THE PEDAGOGICAL SEMINARY AND

JOURNAL OF GENETIC PSYCHOLOGY

Child Behavior, Animal Behavior, and Comparative Psychology

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VOLUME XLVI

1 9 3 5

Published quarterly by the
CLARK UNIVERSITY PRESS
Worcester, Massachusetts
U. S. A.

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Journal of General Psychology

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Quarterly, published in January, April, July, and October. Devoted primarily to experimental, theoretical, clinical, and historical psychology. Manuscripts may be sent to any member of the Editorial Board, or may be sent directly to the general editorial office. *All subscriptions and business communications should be sent directly to the Clark University Press.* Beginning January, 1932, one thousand pages (two volumes) annually. Per annum $14.00; per volume $7.00; single numbers $4.00. *Complete sets* from 1927 at $7.00 and $9.00 per volume, plus transportation.

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Quarterly, published in March, June, September, and December. Devoted to child behavior, animal behavior, and comparative psychology. Manuscripts may be sent to any member of the Editorial Board, or may be sent directly to the general editorial office. All subscriptions and business communications should be sent directly to the Clark University Press. Beginning January, 1932, one thousand pages (two volumes) annually. *Per annum* $14.00; per volume $7.00; single numbers $4.00. Complete sets from 1891 at $7.00, $8.00, and $10.00 per volume, plus transportation.

CLARK UNIVERSITY PRESS
Worcester, Massachusetts
U. S. A.

$7.00 per volume
Single numbers $4 00

QUARTERLY

March, 1935
Volume XLVI, No 1

Two volumes per year

Founded by G Stanley Hall in 1891

THE PEDAGOGICAL SEMINARY AND
JOURNAL OF GENETIC PSYCHOLOGY

Child Behavior, Animal Behavior, and Comparative Psychology

MARCH, 1935

Chacque article est suivi d'un résumé en français
Jedem Artikel wird ein Referat auf deutsch folgen

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Entered as second-class matter December 1, 1927, at the post-office at Worcester, Mass., under the Act of March 3, 1879

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THE RÔLE OF MOTIVATION IN LEARNING: A STUDY OF THE PHENOMENON OF DIFFERENTIAL MOTIVATIONAL CONTROL OF THE UTILIZATION OF HABITS*[1]

From the Psychological Laboratory of the University of Chicago

ROBERT LEEPER[1]

I INTRODUCTION

In this paper are reported three closely related experiments bearing on the question of the function of motivation in directing the utilization, or expression, of habits All three experiments are maze experiments with rats, and all have been concerned with the specific problem of whether rats can learn to select one route when hungry and a second when thirsty in a learning situation in which the external environment is kept constant, but the motivation is alternated irregularly from day to day. The three different experiments, which differed primarily in the nature of the external situation presented to the animals, have revealed vast differences in the rapidity and completeness with which the problem was mastered, and consequently answer fairly well the question of what causes this learning problem to be difficult or easy for these animals.

II THE THEORETICAL ISSUES INVOLVED

The principle of learning which is most generally recognized is unquestionably that learning is very significantly dependent upon motivation This has not received universal acceptance, but through all of the controversies that have raged over and around this principle, it has managed to keep a much stronger position than any of the other concepts commonly discussed under the topic of the "laws of learning" Many psychologists regard this principle—the general law of effect—as so obvious that they would regard with amusement any

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*Accepted for publication by Carl Murchison of the Editorial Board.

[1] This study was conducted while working on a National Research Fellowship I am indebted to Professor K S Lashley for a number of important suggestions and criticisms in connection with this study Thanks are due also to the University of Chicago for generous provision of laboratory facilities

suggestion that it might be defective in any major respect. Nevertheless, it is a purpose of this paper to challenge the general law of effect as commonly understood, and to demand that a more accurate interpretation be made of the data which have been used as evidence for the idea that motivation is basic to learning.

Since the point of my criticism depends upon what is meant by "learning," it is necessary to define this word immediately By the word "learning" I refer to the acquisition of new modes of response (using "response" in the broad sense which includes activities which cannot be outwardly observed, such as visualizing some scene). This definition is not an adequate one in many ways, but it perhaps is adequate to make the distinction which I feel is necessary in the present discussion—the distinction, in other words, between *acquisition* on the one hand and *utilization*, or *expression*, or *performance*, on the other hand.

This distinction between learning and performance, or between habit formation and habit utilization, is a distinction which is clearly drawn, not only in some discussions in psychology, but also in much of popular thought. Even children make such remarks as "I know how to do that, but I don't want to, now" However, in technical discussions of the relation of motivation to learning, this distinction has been neglected almost completely, and this neglect has been responsible, I believe, for considerable misinterpretation of the evidence generally considered as bearing on this problem. As I will attempt to show, the reason that the law of effect seems to be so impregnable and so extensively important is merely that, in the statement of the law of effect, conditions are laid down not merely with regard to acquisition, but also with regard to utilization. Most of the evidence which has been adduced in support of the law merely indicates that motivation is important for one or the other of these two (or maybe for both), but it gives no real evidence that motivation operates as claimed in acquisition.

This criticism does not imply any new and unfair interpretation of the law of effect This principle has been understood by its defenders as being a law of acquisition. Many of Thorndike's statements, for example, could be cited to show that he unquestionably thinks of the law in this sense. Thus, in his recent book, *The Fundamentals of Learning* (15, p. 482), Thorndike indicates this position in his answer to the criticism which has been made that the law of effect implies that causes work backwards in time This criticism is without point, he says, because we need only to assume that there are conditions of satisfaction and of dissatisfaction capable of influencing nervous activity and that there is a lasting-over of the neural patterns from a response long enough for them to be affected —stamped in or stamped out—by such following conditions Such statements indicate clearly that Thorndike regards the law of effect as a description of one of the most important conditions of acquisition, rather than as a blanket statement referring to both acquisition and utilization in one undifferentiated combination. Reference to other writers indicates that most of them also have understood this principle in the same sense (see Waters' review of discussions of the law of effect, 22).

Assuming, now, the validity of the distinction between acquisition and utilization, we may consider whether the evidence given in support of the law of effect is adequate to establish this principle as a law of acquisition Thorndike's statement of this law ran, it will be remembered:

> Of several responses made to the same situation, those which are accompanied or closely followed by satisfaction to the animal will, other things being equal, be more firmly connected with the situation, so that, when it recurs, they will be more likely to recur; those which are accompanied or closely followed by discomfort to the animal will, other things being equal, have their connections with that situation weakened, so that, when it recurs, they will be less likely to occur. The greater the satisfaction or discomfort, the greater the strengthening or weakening of the bond. (14, p. 244)

Let us examine the conditions under which this law is true Suppose that an animal has learned to run a maze in order to get food to satisfy its hunger, but that, after a period of such training, the animal is fed till its hunger abates and then is placed at the start of the maze. What happens, of course, is that the animal wanders about aimlessly, as though it had no knowledge of the correct path. Now, this illustration in no way proves that the law of effect as quoted above is incorrect. For, as regards this example, it might reasonably be said that this is not a case in which the original situation has recurred, since the situation to which the animal responded in the first place was "being hungry and being placed at the start of *the maze*." I would be glad to agree that the word "situation" should be understood in this broad sense. However, let us note what we have done! We have agreed that the law of effect describes the outcome only in case the motivation in question is present both at the time of *acquisition and* at the time of utilization. And, as a matter of fact, even though we have clear evidence that motivation is required for utilization, we do not have similar evidence to show that without motivation, there is no acquisition. Indeed, we have some good evidence that *motivational* satisfaction is not required for some learning, at least [see the "latent learning" experiments of Blodgett (1) and of Haney (8) in which rats were given a number of runs through a maze without reward and then were given further trials in the regular manner *with reward, with the result* that the error and time scores did not fall at all until reward was introduced, and then fell precipitously].

Or let us consider a second type of experiment advanced as supporting the law of effect—experiments on the question *of whether* the strength of motivation affects the rate of learning In a typical experiment on this problem, the procedure consists solely in the comparison of the error scores of two groups of animals, one group of which is moderately hungry when run and the other group of which is intensely hungry. When it is found, in such an experiment, that the error curve for the more intensely motivated group falls more rapidly than the error curve of the other group, this is accepted as evidence that the one group has learned more rapidly than the other But is the matter so simple? Suppose, at a point late in the training, the intensely motivated group was given further trials under conditions of rather weak motivation. Its error scores would mount in such a case This can mean only one thing, namely, that the performance of each group is a function not only of how much they have learned, but also of how effectively they are motivated to use what they have learned. In other words, although the results of such experiments commonly are interpreted in terms of the effects of motivation on acquisition, there is actually no basis for concluding anything regarding acquisition alone. Such an experiment has made the mistake of not drawing a distinction between acquisition and utilization.

An experiment could be devised which would determine whether greater motivation results in more rapid acquisition on such a learning problem, but the essential point in such an experiment would have to be that, at the conclusion of the training, the two groups would be brought to a state of equal motivation before they were given the crucial tests to determine whether either group had learned more than the other. Only by this means could it be determined whether the differences in the preceding error curves had been due to the relation of motivation to utilization, or to some extent also to the relation of motivation to acquisition

Such observations as have been mentioned above have led to criticisms of the law of effect by several writers Another study which has led in this same direction is the study by Tolman, Hall, and Bretnall (20) This experiment compared the error curves on a "punchboard maze" of several different groups of human subjects. One group was punished by electric shock on incorrect choices; another group was punished on correct choices The group punished on right choices made fewer errors than the other group. A very similar experiment, but with rats, has been reported by Muenzinger (12) He found that rats given a shock in the correct pathway of a T maze eliminated their errors only slightly less rapidly than rats shocked on entering the wrong alley. The interpretation of these two experiments is not altogether simple, because it is necessary to assume that the subjects in both cases were driven to seek the correct exit by a motivation stronger than the deterring punishment. And this other, or positive, motivation would be expected, according to the law of effect, to result in an establishment of the correct response However, despite this complication in the interpretation, it seems true nevertheless that the results are counter to the simple law of effect. For, since the positive motivation was (presumably) equally strong with both groups, an equal learning rate would have been expected from the operation of the positive influences And, if it is true that punishment tends to stamp out the responses with which it is associated, the responses that were affected by punishment-plus-reward should have been acquired more slowly than the response of the control group, in which the influence of the stamping-in satisfaction would not be neutralized to some extent by the influence of some measure of punishment.

Such observations as the above have led a number of psychologists to demand that a clear distinction be made between learning and the utilization of learning Lashley (10, pp. 553-554) remarked

> The law of effect, in its various forms, confuses learning with performance. The animal learns to go where food is obtained in the maze and when hungry goes there. Under other conditions he may show an equal familiarity with other paths in the maze. The evidence suggests that the drive is one of the associated elements in the maze habit rather than the agent responsible for the association.

A somewhat similar statement was made by Elliott in 1930 (7), but with the further suggestion that the utilization was controlled not merely by the drive present but also by the animal's "expectation" regarding the goal-material to be secured. And, finally, Tolman, Hall, and Bretnall (20) and Tolman (18) have treated the matter further by suggesting that it was possible to define several relatively specific ways in which motivation does affect learning and utilization. Tolman remarks, concerning one of the principles that their earlier article had suggested:

> . . . it seems to have been this Law of Motivation, as it works out in *utilization in performance,* which led to the mistaken Law of effect. An individual who, due to the conditions of the experiment, is strongly motivated to utilize his learning in his performance will, of course, perform more correctly at any given stage of his learning than will an individual who is not thus strongly motivated. But this does not mean that the relative "successes" and "failures" of the alternative acts "stamp in" the one set of acts and "stamp out" the other. (18, p. 469)

The discussions that have been mentioned above have defined so clearly the distinction between acquisition and utilization that there is little need to dwell on this general point. It is desirable, however, that more thought should be directed to the question of what further studies are needed to work out in fuller detail the principles suggested above as to the relation between motivation and learning. In the first place, it is very desirable that considerable work should be undertaken on the question of whether there are functionally distinct forms of learning, and if so, what they are. Work on this problem is obviously fundamental for work on many other problems of learning. It is highly improbable that in so heterogeneous a field as that of learning all of the materials will be obedient to the same principles. Thus, it is altogether possible that certain statements concerning the function of motivation will be true enough for one part of the field of learning but will not necessarily hold at all for other portions of this field. As an example, I would call attention to the fact that although the utilization of maze habits seems to be rigidly dependent upon adequate motivation, no particular motivation at all seems to be required for the utilization of habits of sensory organization such as I have described elsewhere (11).

In the second place, it seems that it would be desirable, in further studies of the relation of motivation to learning, to make an even finer division of the different stages or phases of learning (for any given type of learning) than was mentioned by the authors quoted above Not only do we need to make the distinction between acquisition and utilization, but at least with some examples of learning we need to make a finer division in order to have the stage cleared for effective thinking regarding the rôle of motivation In particular, the phase that has been called "acquisition" above needs to be recognized as composed partly of *discovery of the solution,* and partly of the *fixation* or implanting of the discovered solution. It hardly seems that this subdivision of "acquisition" would be required in connection with all examples of learning—when a person memorizes a piece of prose it is hard to see that there is anything that might be described as a discovery of the solution, unless perhaps the person invents some scheme of associations as an aid to memorization—but in other examples of learning it seems clearly apparent that the main difficulties of the learner are in discovering the correct solution, rather than in making the results of that discovery part of his permanent equipment once the solution is found

Several writers have emphasized the importance of motivation for the phase of learning that we have designated as the discovery of solutions. Carr (3) has attached considerable importance to motivation in this connection, particularly because of its causing a persistent and active attack on the learning problem. Obvious examples of this point could be cited from experiments on mazes and problem boxes, or from Kohler's insight problems Still another person who has stressed greatly the significance of motivation in this connection is Lewin. Lewin's points cover somewhat the same ground as Carr's suggestion, but are expressed with a different emphasis, since Lewin's discussion of motivation is in terms of its being one of the forces tending to produce or to obstruct a reorganization of the animal's perceptual field. Some of Lewin's experiments have been very cleverly devised to explore these concepts, and leave no doubt about the importance of motivation in this connection.

There is room for considerable further work on the problem of the ways in which motivation affects discovery of solutions It seems, for example, that one way is that motivation makes an animal less responsive to distracting stimuli—noises, fatigue, extraneous objects, etc Insofar as discovery is accomplished by perceptual reorganization, perhaps this is favored by the relatively steady fixations that motivation sometimes produces, just as in first getting the phenomenon of reversible illusions a learner is helped by prolonged fixation More work is needed along the lines mentioned by Tolman, Hall, and Bretnall (20)—that is, that motivation in different cases sometimes has a disrupting influence, especially if too intense, and sometimes an emphasizing function.

Regarding the second phase of learning, or fixation, there is also much room for work Experiments are needed to disentangle the processes of fixation and utilization and to determine to what extent motivation is important for fixation alone. The latent learning experiments of Blodgett (1) and Haney (8) seem to indicate that motivational satisfaction is not required for some examples of learning, but these experiments do not by any means establish the idea that motivational satisfaction has no influence at all on fixation or that it is a minor factor, at the most, in relation to fixation in all forms of learning.

With regard to the relation between motivation and utilization, a number of experiments have already been done There have been experiments on the effects of removal of reward (21) and on change of reward (4). Bruce (2) has reported a study on the effects of lessening of drive. Elliott (5, 6) has reported an interesting group of experiments on the question of what happens when motivation is shifted from one field to another, but with the same response required After rats had been trained to run a maze for food, further trials were given with thirst as the motivation and water as the goal-material. These experiments demonstrated quite clearly that the habits or knowledge in such a case are independent of the specific motivation which was related to their development, and that different motives may be equivalent to each other in their capacity to govern the utilization of the habit. Still another line has been explored to some extent by Hull (9), who sought to determine whether one response could be governed by one motivation and another response to the same external situation be governed by another motive. In his study, the rats mastered the learning problem so extremely slowly that it seemed to suggest that motivation has only a rather precarious relation to utilization And since it is clear that motivation is of great importance for acquisition-plus-utilization, a conclusion which tends to be suggested indirectly by Hull's study is that motivation must be related to learning chiefly through a stamping-in and stamping-out function

The experiments reported in the present paper are a development of the last problem mentioned above The experiments were begun before Hull's work was published, and without knowledge of his work, but they nevertheless are very close to his study in many particulars The hypothesis which the experiments were planned to test was this:—If motivation is importantly related to utilization, one of the prime functions of motivation would seem to be that of determining which associations, or which habits, are to be utilized in any particular situation Everyday observation does seem to indicate that motivation serves this purpose, and the question seems of sufficient theoretical significance to warrant experiments to check this everyday observation.

III The Present Experiments

1. *Experiment I* (an experiment with a two-way tunnel maze, with both end-boxes open) The first experiment was designed particularly to answer the question of whether rats can learn to follow one path in a simple two-way tunnel maze when hungry, and the other path when thirsty, when these two motivating conditions are used on irregularly alternating days The suggestion for this experiment developed out of Tolman's interpretation of habits (16) as "means-ends-readinesses" (which, being translated, means that animals behave as they do, not because of any relatively meaningless or mechanical stimulus-response connections, but because their training has taught them that certain stimuli indicate certain consequences, or that certain routes, tools, etc. can be used to secure certain results). Out of this concept, which attributes to motivation a leading part in the work of securing the utilization of habits, there very naturally

and logically was suggested the experiment which is here reported. For, if habits are of this sort, it naturally follows that an animal should have no difficulty in adapting its response immediately when its motivation is changed, provided its past experience has given it a basis for knowing that one response leads to one consequence and another response leads to a second consequence.

Apparatus. Eleven of the rats used in this experiment were trained on Maze I*A* (see Figure 1). Twelve other rats were

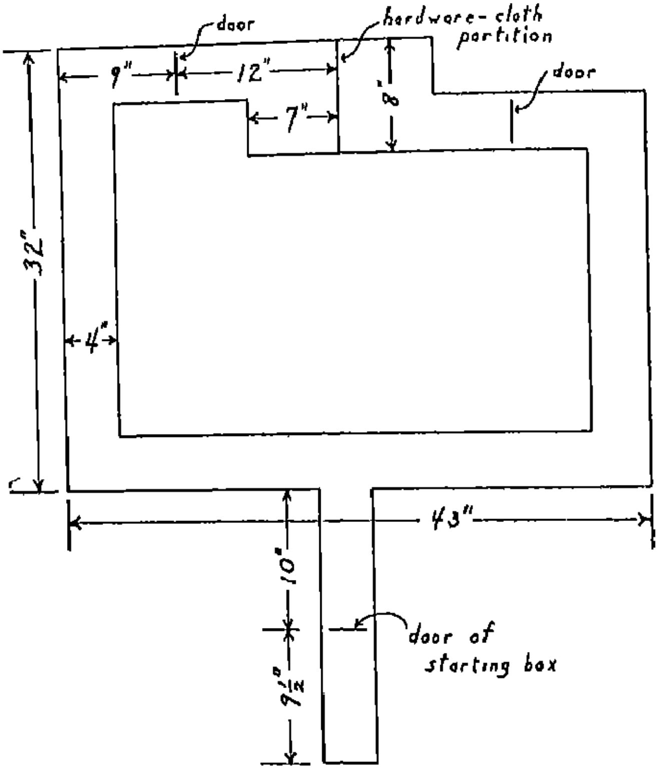

FIGURE 1

Top-View Diagram of Maze I*A*

The dimensions given are inside dimensions trained on Maze I*B* (see Figure 2) The mazes had no floors of their own, but rested on a sheet of brown battleship linoleum which was mopped up before each day's work and at whatever other times

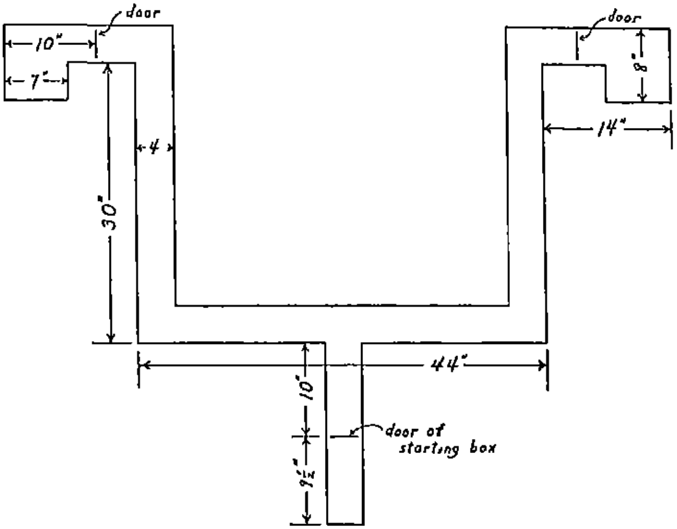

FIGURE 2

Top-View Diagram of Maze I*B*

the floor became soiled during the course of a day's work. The tops of the tunnels were covered with ½" hardware cloth The height of the tunnels was 3¼" The walls and the doors (which were wooden boards arranged to slide in vertical grooves) were constructed of light wood, painted flat black The surroundings of the mazes were by no means homogeneous—extra-maze cues were present in considerable number To the right of the maze was a large desk. To the left of the starting box was the rack of living cages. The experimenter sat at the right of the end-boxes of the maze, at the desk mentioned before The lighting overhead was not symmetrically placed. Moreover, since one wall of each end-box was constructed of ½" hardware cloth to permit the rats to orient themselves by these extra-maze stimuli while in the end-boxes, these extra-maze stimuli were probably part of the situations to which the rats reacted on each run. Whether so or not does not matter from the standpoint of this experiment, for all of these environmental details were constant from day to day, and the question of the experiment was the question of whether the rats could vary their reactions to the same external situation.

In addition to the mazes described above, a straightaway was used for preliminary training of the rats. This was constructed in all general features like the two mazes, but had merely a straight tunnel 24″ long between the door of the starting box and the door of the end-box.

Subjects. The rats used in this experiment were hooded rats approximately four months old at the beginning of training. All but 3 of the 23 rats were males. None had been employed in any previous experiment.

Procedure. The same procedure was used with the rats on both mazes. Five days of preliminary training on the straightaway, with 3 to 5 trials daily, preceded the training on the mazes. On these preliminary trials the rats were rewarded with milk-soaked bread. Following this preliminary training the rats were given 3 trials on each of the first 2 days, and 5 trials on each day after that on one or the other of the regular mazes. On some days the rats were hungry, on other days thirsty. The days on which these two motives were used are indicated on the graph of the results, and therefore need not be detailed here. All rats had the same program of alternations of motivation after their first group of hungry days, but some rats were given 4 days of training with hunger as their motivation before thirst was first used, and other rats were given 5 days. In graphing the results, however, the data on the rats given only 4 days of training under hunger at the start have been shifted ahead one day, so the graphs present the results as though all of the rats had been hungry or thirsty on the same day.

The procedure that was used to secure hunger was to allow the rats to feed on dry powdered food (with water also before them) for 1½ hours after their day's runs. They then were left without food, but with water before them, until the next day's runs, 22½ hours later. The food used was a commercial rabbit food (Domino Rabbit Pel-ets, manufactured by the Nowak Milling Corp. of Hammond, Ind.), which was supplemented occasionally by small quantities of lettuce or other green stuff. To secure the thirsty condition, the rats were allowed to eat this dry food and to drink for a period of 2 hours after their runs, then the water was taken away, but the dry food left before them until they were run 22 hours later. These periods of eating and drinking were increased or decreased in the cases of those rats with which this was needed to keep them in approximately the same physical condition as the average of the group. With the food used, this schedule kept the rats motivated fairly strongly, but not intensely. The particular schedule used was selected because it seemed to yield, as nearly as could be told from observation of the behavior of the rats, approximately equal motivation under the two conditions used.

One detail of procedure which is important to record is that for any given rat one end-box always contained water and the other end-box a pan of dry food, and that on all trials both end-boxes were open, so that a rat could enter either end-box. The rats were permitted to leave the wrong end-box and to traverse the path to the correct end-box during the training of the first 4 or 5 days (more exactly, until after the first thirsty run for each rat). After this point, however, if a rat entered the incorrect end-box the door was closed and the rat imprisoned there for about 20 to 25 seconds before being lifted out and carried to the starting-box. During the period when this latter procedure was used any rat that entered the wrong end-box on its fifth trial was given a sixth trial, in order that the rat might not have made an error immediately before being placed on the feeding-platform. In only one case in all of the days of training was it necessary to give a rat 7 trials in order to have the rat finish the day with a successful run.

On the trials that were correct each rat was allowed to drink for a few seconds if thirsty, or to eat for a slightly longer time if hungry, and then was lifted out by hand and carried to the starting-box. There it usually was allowed to remain until, by its scratching at the exit door, it indicated that the mouthful of dry food that it had grabbed up had been consumed. After a rat's last run for the day it was allowed to eat for about a minute in the food-box, or, on thirsty days, to drink till it first turned away from the water pan. It was then placed on a feeding-platform till all of its cage-mates were run, then the feeding was completed in the living-cage.

The order in which the rats were run was kept constant from day to day, but in order to reduce risk of tracking, the locations of food and water were reversed for each successive cage of 3 or 4 rats.

The definition of errors that was used was this: If a rat pushed its nose past the corner of the maze which permitted looking through the end-box door on that side, an error was counted. As Hull noted in his experiment, however, only very infrequently would the rats start in the wrong direction from the choice point and correct themselves before they had entered the end-box on that side, and of those runs on which such corrections were made, very few were cases in which the arts had travelled more than a foot or so from the choice point.

The rats used on Maze 1*A* were trained for 56 days, and the rats on Maze 1*B* for 42 days. Only the results for the first 26 days of regular training are presented on the graphs, however, because the later trials were used for various controls, which will be described separately, and also for certain other tests not relevant to the problem of this paper. It might be appropriate to mention, however, that in this later period, in the scattered trials where standard conditions were used, the performance was superior even to that reached near the end of the 26-day period.

Results. Little need be said regarding the main results of this experiment, for the important data are summarized almost entirely by Figure 3. Attention is called particularly, however, to the solid line in Figure 3 which represents the percentage of the rats that were correct on the first trial of each day. This is probably the most important line on the graph, because the first trial affords the best indication of whether rats can readjust their responses immediately when the motivating conditions are changed. The data of this graph show that the rats rather quickly reached such a high level of accuracy as to demonstrate quite unmistakably the phenomenon of differential motivational control of habit utilization. Even after two or three days in succession with the same motivation the rats apparently had no difficulty in changing their response when the motivation was shifted.

The line in Figure 3 which represents the average percentage correct on trials 3, 4, and 5 of each day shows very much the same trend as the line for trial 1. However, the behavior on the second trials differed in a very interesting way from the behavior shown on the other trials The phenomenon that seems to be revealed in these second trials is in a field apart from the main purpose of this experiment, but I mention the point because of the considerable significance

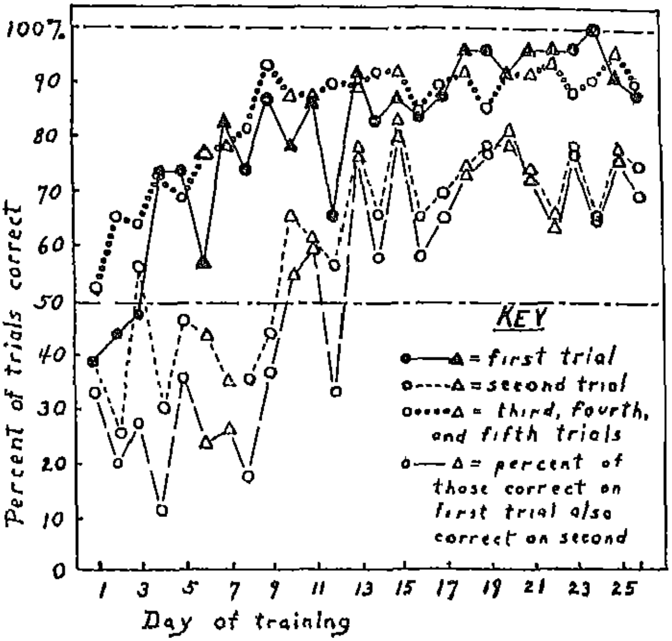

FIGURE 3

RESULTS OF EXPERIMENT I IN THE TERMS OF THE PERCENTAGE OF THE TOTAL GROUP CORRECT ON DIFFERENT TRIALS

The circles represent scores on the hungry days, the triangles the scores on thirsty days.

which it may have Early in the experiment it was noticed that there seemed to be a very strong tendency for the rats to run incorrectly on their second trials, and particularly so in those cases when the first trials had been correct. Since the maze which was being used in the early part of this experiment was Maze I*A*, I was inclined to attribute this tendency to these two factors: (1) the pattern of the maze did not give the rats an opportunity to learn the locations of the goal-materials in terms of any general direction orientation (I was not then familiar with the studies of Loh and of Ballachey that seem to have disproved the concept of direction-orientation in maze learning), and (2) the last two turns that a rat had to make before entering the correct end-box were in a direction opposite to that required at the choice point on the next run. It seemed desirable to check this hypothesis, and consequently Maze I*B* was constructed and the group of 12 rats started on it. However, the rats on this second maze revealed this same phenomenon Indeed, on about two-thirds of the days in the period covered by Figure 3 the rats on Maze I*B* showed an even more marked tendency to run incorrectly on the second trial after having been correct on the first than did the rats on Maze I*A*

This peculiar tendency on the second trial suggests that the matter of the origins of the variability of behavior offers a fruitful field for further exploration It has long been recognized that variability of performance is of importance for learning—that it is, in fact, one of the things which makes learning possible. However, but little thought has been directed to the problem of whence variability arises. Insofar as the matter has been treated, it seems fair to say that variability has been attributed to two sources: (*a*) to the fact that when an animal has reacted in one way and has failed to secure reward, or possibly has met some punishment in consequence, some learning tends to result which will lessen the chances that the same response will be repeated, and (*b*) to the fact that behavior in any given situation is apt to be the product of the chance combination of a large number of more or less independent factors, and that in the early trials in a new learning situation there is not enough learned on any one trial to prevent the occurrence by chance of a different combination of these factors on the next trial. However, neither of these principles would explain the second-trial alternations which we have noticed in the present experiment, because the alternations occurred in spite of the facts that (*a*) the animals had secured their reward, and (*b*) the performance on the second trials was wrong by more than a chance amount, particularly if it is remembered that the performance on the other trials of the day indicated that there was a strong habit factor present and that the rats in question were presumably those that knew the maze better than the average of the group, since they were the ones on the first trial

The data, in other words, raise the question whether there may not be present in such situations as this a *systematic tendency to variability*—whether variability is the result not merely of chance, and of failure to secure reward, but also of certain other systematic forces Perhaps there is a mechanism somewhat analogous to that which Lewin has described—that is, when the rat comes to a choice point on its first run there may be tendencies to go in both directions; going in one direction decreases the tension associated with the tendency to go in that direction, and hence on the next trial the rat tends to pick the other alternative, which now has the greater tension associated with it. That tension also discharged, the rat tends to run correctly for some trials thereafter Whether such an interpretation as this is a good one, I do not know; but I do feel at least that there is some process here which is perhaps fundamentally related to the question of the origins of variability of performance, and it would seem that the matter deserves further research

Controls. Various controls were needed to make certain that the varying performance of the rats was not governed by some varying feature of the external environment, rather than by the variations of motivation within the animals. The danger of such external control of the responses was not great, of course, because almost all experiments on discrimination habits find it a difficult task to set up such habits in rats, and to set up discrimination habits to such external cues as might conceivably have existed (unknown to the experimenter) in the present experiment would certainly have required very protracted training, if they had been possible at all. The one danger which was most real was that the rats might follow the tracks of those rats that had run through the maze previously However, several features of the experimental procedure and results give assurance that tracking was not the basis of the high performance attained The rat that was run first on each day's trials could not have tracked, and this rat had 90% of its first trials correct on days 7 to 26 of the training Similarly, the rats that were run as the first rats in the different cage-groups demonstrated as high a level of accuracy as the other rats, although they would have tended to do more poorly if there had been dependence on tracking, since each successive group was run in the opposite direction from the preceding. A special check on this tracking problem was secured with the rats on Maze I*A* by rearranging the order of running on days 26 to 28, so that the direction of running was reversed with each successive rat. Out of the 33 first trials in these days, 97% were correct.

The most important check on this matter of tracking was secured, however (on days 30 to 32 for the Maze I*A* group, and on days 27 to 29 for the Maze I*B* group) by placing under the maze a sheet of newspaper, changed after every rat, so that the floor of the starting-box and maze paths was covered to within an inch or so of each of the turns immediately following the choice point. By this means a different floor was secured for each rat, and since the newspaper floor extended about 18" on either side of the choice point, this device would seem to have provided an adequate protection against tracking On the first day of this control the performance of the rats was, naturally enough, considerably disturbed. The rats crept timidly out of the starting box, hesitated at the end of the newspaper, etc Only 61% of the first trials were correct on this day. However, on the second and third days of this control, although the rats apparently still were disturbed somewhat by the changed flooring, there was only one mistake in the 46 first trials. It seems quite certain, therefore, that the rats were not depending upon tracking for their guidance.

In order to find whether the rats were guided by the manner in which I placed them in the starting box, or by some other unconsciously given differential cue, still another control was tried. Another person with no experience at all in rat experiments was called in to run the rats on Maze I*A*. Of 10 first trials there was but one mistake.

In still another control, the rats on Maze I*A* were run with the experimenter hidden from the sight of the rats by a screen Of 11 first trials, all were correct

To answer the question of whether the two motivating conditions were approximately equal in effectiveness, appeal may be had to an inspection of Figure 3, or to Table 1, in which are given the percentages correct for the different trials for the hungry and thirsty days respectively from day 6 to 26 of the training. It may be seen that, although the accuracy was slightly greater on the thirsty days, the difference is slight

TABLE 1

PERCENTAGE OF RESPONSES CORRECT ON DIFFERENT TRIALS UNDER THE CONDITIONS OF HUNGER AND THIRST RESPECTIVELY IN DAYS TO 26

Trial	Hungry days	Thirsty days
1	86	86
2	63	67
3	84	88
4	93	90
5	85	86
All	82	84

From Table 1 it may be noted also that there was no consistent tendency for the performance to become better as the later trials were reached, although Hull, in his somewhat similar experiment (9), reported such a tendency in his data. The failure of the rats to evince such a trend cannot be attributed to any abatement of the motivation within the span of the five trials given, because, in a special test given after the period graphed in Figure 3, it was found that the motivation was adequate for an even larger number of trials In this test, each rat on Maze 1*A* was given 20 trials in succession In Table 2 are shown the percentages correct in the successive groups of 5 trials.

TABLE 2

PERCENTAGE OF CORRECT CHOICES IN SUCCESSIVE GROUPS OF 5 TRIALS UNDER HUNGER AND THIRST RESPECTIVELY

	Trials			
Motivation	1-5	6-10	11-15	16-20
Hunger	84	88	76	88
Thirst	100	97	80	53

In the above discussion of the results most emphasis has been laid on the first trials However, as may be demonstrated now, the high percentage of correct responses on the later trials of each day corroborates the evidence of the first trials At the conclusion of the regular training—i e , at the end of 51 days for the rats on Maze 1*A*, and at the end of 37 days for the rats on Maze 1*B*—the rats were given 5 days of further training with the locations of the food and water reversed On the first of these 5 days 11 of the rats were hungry and 12 thirsty, on the second day the motivating conditions were reversed but not changed after that. It may be seen from Table 3, which summarizes the results for this period as well as for the last normal day preceding this period, that the relearning was slow enough to indicate that the successes on the later trials of each day in the earlier training could not be attributed mainly to the experience of the first trial, but were dependent upon long time habits that had been built up. It is of interest here to note also that during the period with the routes reversed there was a very pronounced recurrence of the tendency for the rats to be incorrect on the second trial after having been correct on the first. However, it is of course altogether possible that this phenomenon had a different significance here than it had during the early original training.

TABLE 3

PERCENTAGE OF CORRECT RESPONSES DURING THE 5 DAYS OF TRAINING WITH THE ROUTES REVERSED AND DURING THE LAST DAY OF NORMAL TRAINING PRECEDING THIS TRAINING WITH ROUTES REVERSED

		Days with routes reversed				
Trial	Last normal day	1st	2d	3d	4th	5th
1	100	13	4	56	78	74
2	96	22	44	52	39	48
3	100	30	35	87	83	87
4	96	48	39	87	83*	87
5	96	74	56	78	83*	
6		74	78	91	96	
7		65	83	91	100	
8			87	83	83	
9			78	78		
10			87	91		

*These trials were used to make an incidental test of the conditioned-reflex principle of disinhibition. Since the rats had first developed one habit very firmly, and then had developed a second and contradictory habit by short and recent practice, one might have expected, according to the principle of external inhibition of conditioned inhibitions, that the introduction of unusual and distracting noises would tend to interfere with the more recently acquired habit and to allow a resurgence of the earlier and more deeply fixed habit. The noise used as a "disinhibitor" was intense and sudden, and obviously affected the rats, at least as far as their cautious creeping from the starting box serves as an indicator. However, as may be seen, there was but little interference with the accuracy of response.

Conclusions Relatively little need be said here in summarizing the conclusions of this experiment, because some of its points become apparent only through the comparison of it with the other experiments described below This experiment does, however, indicate several points. (1) With the type of maze here used, rats can fairly quickly learn to vary their responses in accordance with changes in their motivation This fact supports Tolman's interpretation of the nature of habits, and also is of significance in connection with the question of the functions of motivation in governing habit utilization, and (2) as an incidental finding, this experiment seems to indicate that variability of response is not due solely to chance and to failure to secure reward, but arises from some other systematic sources as well

2 *Experiment II* (an experiment with an elevated maze with end-boxes of distinctive types) The second experiment of this series was conducted with a rather different purpose in mind than the first experiment In the first experiment it was demonstrated, it will be remembered, that changing motivation is able to determine which response an animal will use In the second experiment, I sought to determine whether motivation could exercise this selective influence even in connection with associations or knowledge which had been developed without any motivational satisfaction having been involved in the learning process This experiment accordingly was patterned to some extent after the studies by Shepard (13) and Tolman (17, 19), but with the added complication that the rats had to choose between the locations of two different positive goals, only one of which would be appropriate to the motivation of the moment

The description of the apparatus and procedure of this experiment will explain its purpose more fully

Apparatus For this experiment it seemed desirable to use an apparatus which would present a very easy learning situation to the rats Accordingly, an elevated maze was used, and the three end-boxes of the maze were constructed so that the rats would be forced to attend, or react, to their differences The starting-box was distinctive also More specifically, the maze was constructed as follows The starting-box, 6" x 11" x 8" in its inner dimensions, and with shavings over its floor, opened onto an elevated path 1¼" wide and 18" above the floor of the room Eighteen inches from the door of the starting-box, this path branched in three directions, two of the arms running off at 90° to the right and left, and the third running straight ahead Each of these arms was 36" long The three different end-boxes to which they ran were somewhat similar in external construction, as may be seen from Figure 4, which shows a photograph of this maze in its usual setting, but the interiors of the end-boxes were markedly different from each other The left hand box was made with a corrugated wooden floor constructed by placing boards at a 45° angle so that the floor was a succession of ridges and valleys with a distance of 3¼" from one ridge to the next, and with a distance of 1½" from the peaks to the bottoms of the valleys The right-hand box was similar in some respects, but was smaller and had a floor made of ½" hardware cloth with a sheet of tin some inches below that The third end-box had a floor of battle-ship linoleum, had a lower ceiling than either of the other end-boxes (3¾" rather than 6"), and had its floor space partitioned off into 8 divisions by wooden partitions pierced by arched doors [illegible]" wide and 2¾" high. Each of the end-boxes was enclosed so that when a rat was in any of them it could not see anything except the interior of that end-box

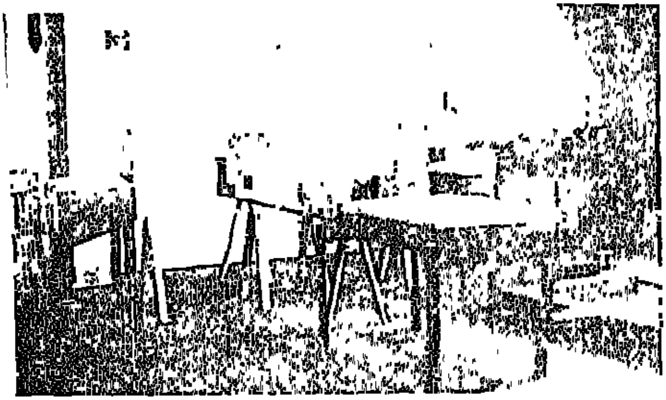

FIGURE 4

PHOTOGRAPH OF THE ELEVATED MAZE USED IN EXPERIMENT II
(On the floor to the right of the elevated maze may be seen a part of Maze *IB* with its starting-box removed)

Subjects The rats used in this experiment were 9 male hooded rats about 3½ months old at the beginning of training The rats had not been used in any previous experiment.

Procedure The first stage in the training of the rats used in this experiment was to allow them to wander on the maze for about 5 hours daily for 32 days, without food or water anywhere in the maze. At the end of each day's exploration the rats were returned to their cages, and after an interval of 15 minutes given their food for the day. This first stage of training was intended to give the rats a thorough knowledge of the lay-out of the maze.

The second and third stages of the training were designed respectively (*a*) to establish associations between particular goal-materials and the interiors of particular end-boxes, and (*b*) to determine whether, after the two earlier stages of training, the rats would be able to piece together the different items of their experience and run to the correct end-box when released from the starting-box when either hungry or thirsty For the second stage of training the end-boxes were separated from the maze proper and moved to a different portion of the room For each rat one of the end-boxes was selected as a dry-food compartment and a second end-box as a compartment for water. The rats were introduced into the appropriate end-boxes individually, being carried in such a manner that it was not possible for them to see the exterior of the boxes into which they were placed. This second stage of training lasted for three days. On the first day they were hungry, and were placed first in the food-box and allowed to eat of the dry food for about 30 to 40 minutes. Then they were removed and placed in the end-box where they were to receive water, and were allowed to stay there for about 20 minutes. Then they were placed in the third of the end-boxes, and allowed to explore its empty interior for about 30 to 40 minutes further before they were returned to the living-cages to receive the remainder of their food. On the second day of this second stage of training the rats were thirsty, and were placed first in the water end-box, and second in the food end-box The third day was like the first.

The third stage of training consisted of the tests on the entire maze to see whether the rats would be able to piece together their past experiences In the first day of this third stage the rats were hungry. On this first day the water-pan was not placed in the maze, since the second day of the training was designed to determine whether the rats could go correctly to the right end-box when thirsty, and without previous possibility of learning the location of the water by trial and error.

The training of this third stage continued for 6 days with 5 trials a day, and with hunger and thirst used on alternate days. Then the cycle of the second and third stages of training was repeated a second and a third time, each time with the locations of the food and water changed. This was done because the rats had failed on their first third-stage tests to combine their previous experiences immediately, and because it was thought that the reason for this might be that the rats had never been trained previously in making a choice between alternative routes.

Two other details of procedure should be mentioned. In the first place, in this experiment the rats were not confined in a wrong end-box if they entered it, but were always allowed to continue their explorations until the correct end-box was found. In the second place, the starting box had no door, and the rats could leave it at their own will. Their departures usually were delayed at least a few seconds, however, as a result of the fact that the door was at a height of 2″ above the maze path.

In order to eliminate danger of tracking, each successive rat ran to a different end-box for food or water.

Results. As Figure 5 indicates, the rats were not able to make an immediate adjustment after their second stages of training. They showed only very slight and unreliable signs of being able to piece together the different items of their experience in this case. This result is different from the evidence which Shepard has reported (13), and different also from the recent findings of Tolman (19), but the difference in outcome between this experiment and theirs is not to be marvelled at, since the period of training was rather brief which was supposed to teach the rats to associate food and water with particular end-boxes, and since this period was necessarily separated by a relatively long interval (about 23 hours) from the test trial. Some of these difficulties were more or less unavoidable with the problem being investigated; other difficulties probably could have been eliminated—thus, it would have been better, perhaps, to have used rats that had previously been trained on some other problem and that therefore possessed habits which might have been transferred to certain aspects of this problem which were irrelevant difficulties, as far as the main issue involved was concerned.

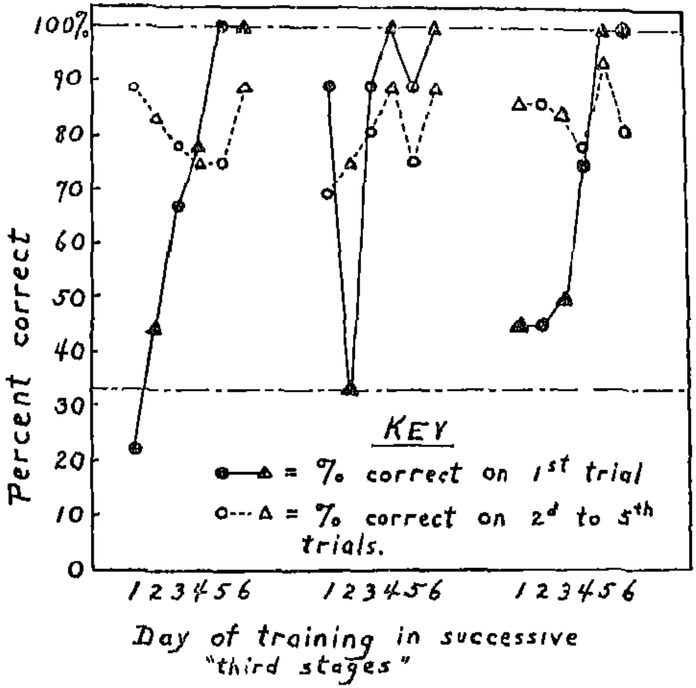

FIGURE 5

RESULTS OF EXPERIMENT II

Percentage of runs correct in three different "third stages" of training on *the elevated maze The circle represents scores on the hungry days, the* triangles the scores on the thirsty days

However, although the results of Experiment II are negative as far as concerns their bearing on the problem for which the experiment was planned, the data are valuable as a supplement to the first experiment described above. This second experiment reveals perhaps even more clearly than Experiment I that the task of adjusting behavior in response to changes in motivation is a very easy task for rats, provided the learning situation is favorable. This second experiment, furthermore, gives additional insurance that the results of the first experiment were not due to some uncontrolled external factor, because in this second experiment the periods of regular training were very brief, the use of three end-boxes reduced the likelihood of chance successes, and the fact that no two rats ran in succession to the same end-box eliminated any possibility of tracking

3. *Experiments III-A, III-B, III-C, and III-D* (Experiments with Hull's maze and with modifications thereof).[7] This third group of experiments was undertaken to determine, if possible, what features of technique or of apparatus had been responsible for the fact that my experimental results differed so strikingly from Hull's.

Experiment III-A. The first experimental check attempted was a straightforward repetition of Hull's experiment The maze used differed from his in that the walls were of wood rather than of metal plates, and in that the floor was of linoleum rather than of wood (in its general style of construction this maze was similar to Mazes I*A* and I*B*—see above) The environment of the maze probably differed appreciably from the environment of Hull's maze. The dimensions of the maze were the same, however, and except for the fact that no control group was used, Hull's procedure was copied as closely as possible—each rat ran in the direction opposite that required of the preceding rat, the rats were run for six days a week rather than seven, as in the two experiments described above, and the motivation was changed regularly from hunger to thirst on each successive day, instead of the alternations being more or less irregular

The maze used is diagrammed in Figure 6 (note, however, that the construction of the end of the maze is indicated by the insert rather than by the main part of Figure 6) The two doors on either side of the end-box could be arranged, as in Hull's experiment, so that on one day each rat would have to select one of the arms of the maze in order to get into the end-box and find food there, and select the opposite arm on the next day in order to get into the same end-box

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[7] The rats in these experiments were trained by Mr Hamilton Crook, whose assistance was made possible by a grant from the Federal Civil Works Educational Service I am happy to acknowledge my indebtedness to the CWES for this financial aid and to Mr Crook for the very careful and able way in which the work was executed.

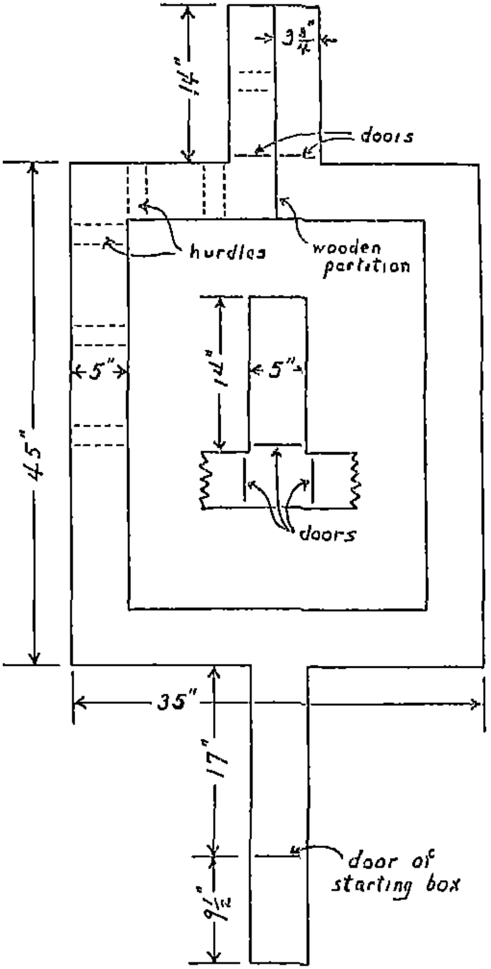

FIGURE 6

DIAGRAM OF THE MAZES USED IN THE THIRD GROUP OF EXPERIMENTS The pattern indicated in the main part of this figure shows the maze used in *Experiment* III-D The maze used in Experiments III-B and III-C was the same, but with no hurdles in the pathway The maze of Experiment III-A had the single end-box, as shown in the insert, rather than the double end-box, but otherwise was identical with the maze of Experiments III-B and III-C

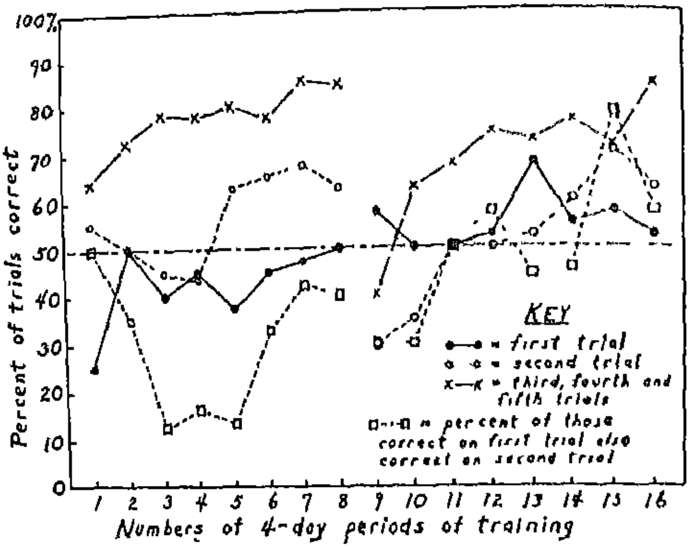

FIGURE 7

RESULTS OF EXPERIMENTS III-A (PERIODS 1 TO 8) AND OF EXPERIMENT III-B (PERIODS 9-16)

to find water there. When a rat chose the arm which was incorrect on that day, its run led it to a closed door, so that it had to retrace its steps and enter the end-box by way of the correct arm.

On this repetition of Hull's experiment, 10 untrained hooded rats, about three months old at the beginning of training, were used. Before the training on the regular maze, 5 days of preliminary training similar to that given the rats of Experiment I were given.

The results of this repetition of Hull's experiment are shown by the portion of Figure 7 which covers the first 8 of the 4-day periods of training. Some indications of learning are given in the later trials of each day, but in the first trials no more than 50% correct was achieved in any 4-day period. The comparison between these results and Hull's results may be seen in Figure 8, for which the first-trial scores have been grouped into 8-day units, following the practice that Hull used in presenting his results. On this same graph have been presented also part of the data of Experiment I

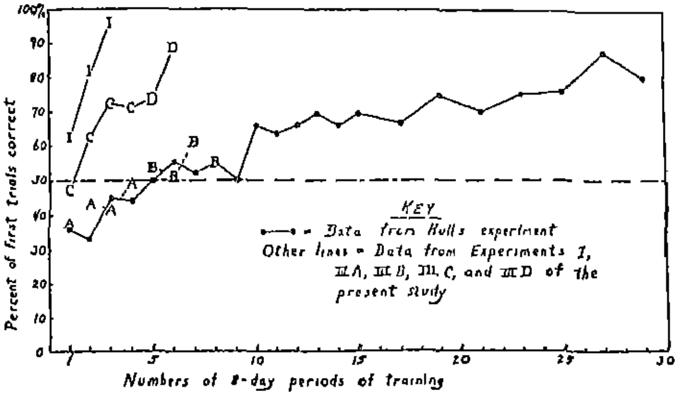

FIGURE 8

PERCENTAGE OF FIRST TRIALS THAT WERE CORRECT IN HULL'S EXPERIMENT (9, *FIGURE 3*) AND IN EXPERIMENTS I, III-A, III-B, III-C, AND III-D OF THE PRESENT STUDY

previously portrayed in Figure 3. As Figure 8 indicates, our repetition of Hull's experiment yielded results that correspond almost exactly with the results of Hull's experiment for the period of training concerned Therefore the striking difference in results between his experiment and Experiment I of the present study does not seem to be due to any possible differences in methods of controlling motivation or to any other differences except differences of maze pattern Accordingly our attention is turned to the question of what feature of the situation presented to the rats caused his results to differ so markedly from the results which I had secured in Experiments I and II

The explanation which is suggested by a comparison of the experiments is an explanation much in line with Tolman's interpretation of the nature of habits and learning. When a rat made an error in Hull's maze, its path led it to a door which firmly obstructed its entrance into the end-box In Experiments I and II above, however, when a rat chose incorrectly, its run led it into the end-box containing the material which the rat did not desire at that time, and the rat thus had an opportunity to learn what materials were in what places. Now, if the effect of an incorrect run is not to be described as a *"stamping out of the connections leading to that response,"* nor as the *"development of a negative conditioned response to that side of the maze,"* but is to be described rather as a matter of the rat's learning the nature of the situation to which each response leads, the results seem to be understandable. According to this hypothesis, in Hull's maze the rats would tend to learn from their incorrect runs that a closed door barred the path on that side, and that that side therefore should be avoided. It is probably this factor that accounts for the fact that in the first four 8-day periods in Hull's experiment, and in the first four 8-day periods in the present experiment as well, the percentage of correct responses on the first trials remained below the fifty-per-cent mark. Of course, as the training was continued in Hull's experiment, the rats finally were able to learn that this closed door was on one side on one day and on the other side on the next day; but it is quite understandable that this problem should have been a difficult one for the rats. As regards my mazes, on the other hand, this hypothesis would indicate that the rats were helped in mastering the problem, not only by their correct runs, but also by their incorrect runs, since, according to this hypothesis, the incorrect runs would tend to result in the rat's learning where the goal-material not desired on that day was to be found, and with the motivation changed on the following days that learning would be available immediately for use.

Experiment III-B. In order to secure a further test of the hypothesis just mentioned, further training was given to the 10 rats whose performance on Hull's maze has been described above, this further training being given with the double end-box shown in the main part of Figure 6, rather than with the end-box as shown in the insert of Figure 6. In other words, in this further training it was possible for the rats on their incorrect runs to enter the end-box containing the goal-material not desired at the time. Except for this one change and except for the fact that the directions to be followed to reach food and water respectively were reversed for each rat, the training continued as before, following as closely as possible the technique of Hull's experiment. Thus, when a rat entered the wrong end-box it was not detained there, but was allowed to leave and to proceed around to the correct end-box. This detail of technique differed from the procedure in Experiment I (see above), but was similar to that used in the experiment with the elevated maze, and, since the learning of that maze was so very rapid, it can hardly be that this detail in itself was any serious obstacle to learning.

With these changes, training was continued for 32 days further. Contrary to my expectations, however, the rats did not show any appreciable improvement in their performance (see periods 9 to 16 of Figure 7, and the "B" line in Figure 8) The thing which did characterize their behavior most strongly during this further training was the continuance of the position habits that most of the group had developed during Experiment III-A This factor of position habits seems to have been responsible for the disappearance, during Experiment III-B, of the tendency to make an error on the second trial after having been correct on the first trial It might be noted here that this tendency, which was discussed in connection with Experiment I above, was displayed quite clearly in Experiment III-A (see Figure 7), and will be seen also in Experiment III-C (See Figure 9).

In searching for an explanation for the failure of the rats to master the problem with the altered maze used in Experiment III-B, it seemed to me that the most logical possiblity was that the rats were handicapped by their previous experience with the one-end-box maze For, in their earlier training, the experience of the rats had taught them that if they found it possible to enter the end-box on the side which they had chosen, that fact indicated that the correct route had been found and that the other arm of the maze was blocked by a door at its end

Experiment III-C To test the hypothesis just suggested, the obvious course of action was to start another group of untrained rats on the same maze as used in Experiment III-B. Accordingly this was done The rats used were 9 male hooded rats about 3 months old at the beginning of the training. The preliminary training, the feeding, and the other details of treatment duplicated those of Experiments III-A and III-B

The results of this experiment are shown in Figure 9 (the first eight 4-day periods of training), and also in part in Figure 8 (see the "C" line there). In this experiment, it will be noted, the rats *did* make definite and unmistakable progress in mastering the problem within the period of the 32 days of training The rate of learning was slower than in Experiment I, but unquestionably much more rapid than in Hull's experiment

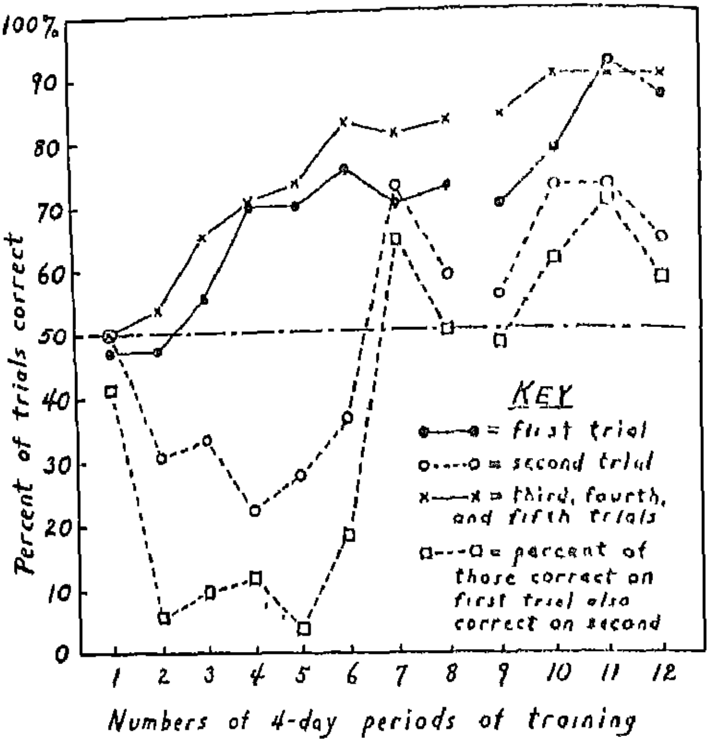

FIGURE 9

RESULTS OF EXPERIMENT III-C (PERIODS 1 TO 8) AND OF EXPERIMENT III-D (PERIODS 9 TO 12)

Experiment III-D. This last experiment, which consists of a continuation of the training of the rats used in Experiment III-C, was conducted in an effort to secure light on the question of why the curve of Experiment III-C had risen more slowly than the curve of Experiment I. As possible causes of the difference in the curves, several differences of technique and apparatus suggested themselves. One such difference was this: in Experiment I the rats were imprisoned for a while whenever they entered the wrong end box, but in Experiment III-C the rats were allowed to back out and to continue their course to the correct end-box. Still another difference was that in Experiment I, and even more definitely in Experiment II, the end-boxes had been more clearly differentiated from each other than in Experiment III-C. For, in the latter case, not only were the two end-boxes indistinguishable in their internal construction, but as a rat sat eating or drinking in either of them, its head was pointed in the same direction as it would have been in the other end-box, and consequently all of the extra-maze environment was almost identical in the two cases In other words, to use one of Thorndike's expressions, the identifiability of the different routes seemed to be greater in Experiments I and II than in Experiments III-B or III-C

Experiment III-D was conducted, therefore, to determine whether increasing the identifiability of the two paths in the maze would serve to increase the accuracy of the choices in the maze used in Experiment III-C Consequently, at six points in the pathway on the left side (as indicated by the dotted lines across the path in Figure 6), low hurdles were placed in the tunnel. These hurdles were made of wooden blocks ¾″ high and 1¾″ wide, painted black. After they had been added to the maze, the rats of Experiment III-C were given 16 days more of training.[8]

Relatively little increase in the group score is to be seen during the first days of Experiment III-D, due largely to the fact that several of the rats were considerably disturbed by the addition of this strange element to the maze, and took up position habits favoring the other side However, the performance did become decidedly better during the 16 days of training, and the change from the level reached in the first 32 days of training seems to be sharp enough to justify the conclusion that the addition of this further detail was the responsible factor, rather than the continued training.

IV. General Conclusions

This set of experiments permits an unequivocal answer to the question of whether motivation can exercise a directive function in relation to the utilization of habits The experiments show that, provided the learning situation affords cues which clearly identify different portions of the situation, a rat can vary its response quite accurately after relatively brief training, adjusting its response to the motivation which demands satisfaction. These experiments therefore support the general idea which Tolman has emphasized, that habits (with the exception of the so called "fixations") are not relatively fixed and mechanical stimulus-response connections, but are to be described rather as knowledge that such and such behavior leads to such and such consequences, which knowledge therefore will be utilized whenever the combination of motivation and external situation calls for the expression of that knowledge. The experiments indicate that the very slow learning and the low level of accuracy attained by the rats in Hull's experiment were due to the characteristics of his apparatus, and not to any lack of distinctness in the two motives (9, p. 270) nor to anything difficult or artificial in the basic task of differential motivation control which was demanded of the rats.

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[8] In this further training it was necessary to change the definition of errors. If a rat thrust its nose past the corner which permitted it to view the long unit of the maze path, in which the hurdles had been placed on the one side, that run was counted incorrect However, there were only a very few cases in which rats went as far as this and then retraced.

As regards the relation between motivation and utilization, the conclusion, therefore, is quite clearcut. This study supplements the other studies of habit utilization which were mentioned in the preface of this paper. Those studies showed that motivation must be present to secure accurate and vigorous utilization of past learning, and also that a variety of motives may be substituted for one another as the means of securing such habit utilization. The present study shows that, although motives may have such equivalence in certain situations, they may serve also as differentiating or selective agents to determine which of several responses will be employed.

As regards the relation between motivation and acquisition (including under this both discovery of solution and fixation), the chief evidence is to be found in a comparison of Experiment III-C with Experiment III-A (or with Hull's experiment). These experiments involved exactly the same procedure and apparatus, it will be remembered, except that in Experiment III-C there was a double end-box, and on an incorrect run the rat could enter the wrong end-box and see the undesired goal-material in it before it retraced its steps to the correct arm of the maze; whereas in Hull's experiment and in Experiment III-A when a rat ran incorrectly its steps led it to a closed door which barred its way into the one end-box, and the rat had to retrace its steps as though out of a simple cul-de-sac. Now, to a hungry rat, it is probably no greater *punishment* to be turned back by a door (as in Experiment III-A) than to be turned back by an end-box containing only a pan of water. Nevertheless, this one difference in the situation seems to make an enormous difference in the rate of mastery of the problem (See Figure 8). It would seem, therefore, that the rats must learn almost as much from their incorrect responses as they do from their correct responses, and it would seem also that this learning does not consist in "having the connections that led to that response stamped out" because there had been failure to secure reward, but consists rather in learning the nature of the situation to which the response led. Since no more motivational satisfaction was met in the incorrect runs of Experiment III-C than in the incorrect runs of Experiment III-A, and since it was apparently the different learning that resulted from these incorrect runs in the two cases which hampered the mastery of the experimental problem in the one case and helped it in the other, the conclusion that seems justified is that learning (acquisition) takes place which is not dependent upon motivational satisfaction or punishment, but which is dependent merely upon the perceptual reaction to the situation.

V. SUMMARY

This article reports a series of experiments conducted to determine whether rats can learn to adjust their responses to a constant external situation in accordance with changes in their motivation. All of the experiments involved mazes. Hunger and thirst were the two motives used. It was found that the rate of mastery of this problem can be either very rapid or very slow, depending on how clearly the different routes and end-boxes are distinguished from one another, and depending on whether, on their incorrect runs, the rats are or are not allowed to enter the end-box containing the goal-material not desired at the time.

In Experiment I, 23 rats were trained in a simple tunnel maze, one arm of which led to food and the other arm to water. The motivation was alternated irregularly on successive days. An accuracy of over 90% on first trials was achieved at the end of 18 days of training with 5 trials daily.

In Experiment II, 9 rats were tested to see whether, after they had had (*a*) extensive opportunity to explore an empty elevated maze with clearly differentiated end-boxes, and (*b*) an opportunity to associate food with one end-box and water with another, the rats would be able to piece together these items from their training without any trial-and-error learning as the basis for the phenomenon of differential motivational control. The rats failed to make an immediate adjustment, but did show remarkably rapid learning, reaching 100% accuracy within five days in three such tests

The third group of experiments sought to determine why the corresponding experiment by Hull (9) disclosed almost no indications of learning in the first several months of training, and only about 77% accuracy on first trials in the first 200 days of training. Experiment III-A repeated Hull's experiment for a 32-day period, and duplicated his findings for this period. It appeared that these results were caused by the fact that, on their incorrect runs, the rats met a closed door at the end of the path, rather than an end-box containing the goal-material not desired at the time. Experiments III-B and III-C were tests of this suggestion, and seem to prove that this was the main factor responsible for the difference in results between Experiments I and II and experiments with Hull's maze. Experiment III-D showed that increasing the identifiability of the maze paths and end-boxes also favors accuracy of performance.

Sections II and IV of the article interpret these results as showing that motivation can exercise a directive function in relation to habit utilization and that, for acquisition or "learning proper," motivational satisfaction is not as important as is commonly believed. This discussion relates these points to the "law of effect" and suggests that the apparent widespread validity of the "law of effect" rests for the most part on a misinterpretation of the relevant experimental evidence.

An incidental feature of the results bears on the question of the origins of variability of behavior in learning situations, and seems to indicate that such variability results not merely from chance and from failure to secure reward, but from certain systematic tendencies to variability as such.

A subsequent paper will report several further studies of this same phenomenon of differential motivational control. One of these studies dealt with maze habits, but the motives used were those arising from qualitative food deprivations. The other experiment sought to find whether the phenomenon of differential motivational control could be demonstrated in the field of discrimination habits.

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LE RÔLE DES MOBILES DANS L'APPRENTISSAGE. UNE ÉTUDE DU PHÉNOMÈNE DU CONTRÔLE DIFFERENTIEL DE L'UTILISATION DES HABITUDES PAR LES MOBILES

(Résumé)

Cet article se compose (1) d'une discussion théorique et historique de la relation entre les mobiles et l'apprentissage, et (2) d'un rapport d'une série d'expériences faites pour déterminer si les rats peuvent apprendre à adapter leurs réponses à une situation extérieure constante conformément aux changements de leurs mobiles Toutes les expériences ont employe des labyrinthes. La faim et la soif ont été les deux mobiles employés On a constaté que la vitesse de l'apprentissage peut être ou tres rapide ou très lente, ce qui dépend de facilité de distinguer les différents parcours et boîtes terminales l'un de l'autre et si, dans leurs parcours incorrects, les rats sont permis ou ne sont pas permis d'entrer dans la boite terminale qui contient le matériel non désiré au moment

LEEPER

DIE ROLLE DER MOTIVIERUNG BEIM LERNEN: EIN STUDIUM DES PHÄNOMENS DER DIFFERENTIALEN MOTIVIERUNGS-KONTROLLE BEI DER BENUTZUNG DER GEWOHNHEITEN

(Referat)

Diese Abhandlung besteht aus (1) einer theoretischen und historischen Erorterung des Verhaltnisses der Motivierung zum Lernen, und (2) einem Bericht uber eine Reihe Experimente, die zur Bestimmung der Frage ausgeführt wurden, ob Ratten ihre Reaktionen an eine bestandige aussere Situation in bezug auf Veranderungen in ihrer Motivierung anpassen lernen können. Alle Experimente wurden mit Labyrinthen ausgefuhrt Hunger und Durst waren die zwei gebrauchten Motive. Es wurde festgestellt, dass die Schnelligkeit des Lernens entweder sehr schnell oder sehr langsam sein kann, was davon abhangt, wie klar die Gänge und Endkasten von einander unterschieden werden und davon, ob die Ratten auf ihren unrichtigen Läufen in den Endkasten, der das Material enthält, das zur Zeit nicht erwunscht war, nicht einzutreten gestattet wurden.

LEEPER

A STUDY OF A NEGLECTED PORTION OF THE FIELD OF LEARNING—THE DEVELOPMENT OF SENSORY ORGANIZATION*

From the Psychological Laboratory of the University of Arkansas

ROBERT LEEPER

THE PROBLEM

The present investigation was designed primarily to demonstrate a type of learning which is not ordinarily recognized in discussions of the nature of learning, and which is not dealt with at all, so far as I know, when such problems have been examined as: what factors influence the rate of learning and forgetting, and what relation does motivation have to learning and to the utilization of habits.

The field of learning is a vast one and a very heterogeneous one We have put an enormous range of concrete things under this one category, until the activities of which it is said to be a part are almost as broad as life itself. Now, the fact that this field is so heterogeneous, at least in superficial appearance, should long ago have impelled psychologists to *a vigorous investigation of the question as to whether this field of learning is functionally homogeneous—i.e., obedient to the same laws and principles—through all of its length and breadth,* or whether, as one would be more inclined to suspect, *there are subdivisions of the field (and probably a whole hierarchy of smaller subdivisions of these) that are functionally similar in certain respects and functionally dissimilar in other respects* If the latter hypothesis is actually the case, the discovery and demarcation of these functionally distinct divisions of learning is obviously of fundamental importance for research in this field. The different forms of learning cannot be expected to be as distinct from one another as are the ailments that constitute the subject matter of medicine; and yet, the possibility of securing an adequate understanding of learning is probably not much greater, if we do not devote ourselves to the preliminary task of finding how to group concrete examples of learning into functionally distinct classes, than would be the probability of successful research in medicine if the

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*Accepted for publication by Carl Murchison of the Editorial Board.

research workers in that field simply tried to deal with disease in general, rather than first trying to classify the different types of disorder.

Although the above notions seem fairly obvious, it seems that psychologists generally have been inclined to search for some one formula which would fit the whole field of learning—a sort of universal solvent, as one might say. Perhaps the reason for this is that other sciences have achieved such notable advances by finding that they could reduce to a few basic things what at first looked like hopelessly heterogeneous fields. Whether this is the reason or not, most psychologists have discussed learning as though they thought that the great diversity that seems to exist among the various examples of learning[1] was merely a surface matter, and not any difference of principle of operation. Now, inasmuch as the various theories of the nature of learning are quite different from one another, one might imagine that at least some of these differences must have come from the fact that different psychologists seized on different types of habit in their search for illustrative material which would seem to them most clearly to lay bare the essential nature of learning. Such a factor is partly responsible for the diversity of theories of habit that exist—compare, for example, the illustrative material of apperceptionism and associationism. However, such a factor is not the main source of the differences of interpretation of learning. For, to a really amazing extent, the different theories of learning have appealed to specimen material which is virtually the same in all cases. This fact can be illustrated by taking an example of learning utilized by Koffka (6) in explaining the Gestalt interpretation of learning, and by showing how readily the other theories of learning could appropriate this same example to explain their interpretations. Koffka uses the example of a small child who reaches for a candle flame, is burned thereby, and who subsequently avoids the flame rather than approaches it. To Koffka this example illustrates a transformation of meaning, or, more particularly, a case of unification The candle now is not "a pretty thing to be played with," but is "a thing which causes pain." But, to the adherents of the association theory, this example would seem to fit *their* theory perfectly—the child was experiencing the sight of the flame and simultaneously experienced the heat, consequently the sight thereafter recalls the thought of the pain which was experienced, and the candle is avoided. And similarly with the other theories. It is so obvious how the redintegration theory, the conditioning theory, and Tolman's theory would fit this example that there is no need to elaborate.

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[1] In this discussion, I am using the expression "forms of learning" in the sense of "forms of habit." The term "learning" most naturally should designate the process of acquisition of some new skill or knowledge, etc., rather than the products or residues of this process. However, the term "habit" has no unambiguous meaning in psychology, sometimes being used to designate responses which have been so deeply ingrained by training that they are automatic, and sometimes being used (and I think preferably, since we have no other word to convey this meaning) to designate the after-effects of learning, no matter what has been learned and no matter how slight or how permanent the impression has been. It is in the latter sense that the word "habit" will be used in this paper. Most psychological discussions of the "nature of learning" are really discussions of the nature of habit, in the sense just defined. The association theory, for example, or the theory of redintegration, or Tolman's theory of sign-gestalt-expectations are not primarily theories of how learning goes on, but are theories concerning the nature of the habits established by learning.

This fact that there are so many theories, all of which appeal to similar factual material for substantiation, suggests two lines of work for the future. For one thing, if these different theories are really different interpretations, and not merely different terminologies, it is high time that experimental tests were devised to determine which of these theories is most adequate for the description of the material which they all concern. This contest certainly is not one which should be settled on the basis of the relative vociferousness or prestige of the different groups Situations such as this are urgent challenges for the construction and use of criteria and techniques which will decide between rival theories. Such a welter of theories is no indication of the wealth of psychology—it is a confession of poverty of experimental resourcefulness.

This paper, however, is not devoted to this first task, but turns instead to a second line of work, suggested by the fact that these different theories of learning all appeal to similar illustrative material. As suggested above, in so extensive a field as that of learning, it is highly probable that there are subdivisions of the material which are functionally different from each other, and the discovery of these divisions is consequently of major importance for psychological research and psychological theory In view of this probability, we need to explore the whole field of learning to discover whether there are some portions of that field not covered by the existing theories. If any such examples are found, clear-cut specimen materials from these portions of the field should be sought and, in the second place, criteria should be devised and applied to ascertain whether this material really is different in the principles of its operation from the specimen material commonly stressed by the present theories of learning. It is toward these goals that the present study is headed, although it is only a very slight beginning in this work This investigation did not attempt to ferret out all of the territory not covered by existing theories, nor, even with the field with which it does deal, has it succeeded in devising any crucial tests to determine whether there is any functional novelty in the material found. The contribution of this study is limited to the closer examination and clarification of a particular portion of the field of learning which seems to be distinct from the portions ordinarily studied and to be, for several reasons, of considerable theoretical interest

The type of learning examined in the present study may seem to many readers to be a type already strongly stressed by Gestalt psychologists, for this investigation is a study of sensory organization, a study of the unification of sensory materials into dynamic or organic wholes Of course, the phenomenon of sensory organization owes its present solid status in psychology to the Gestalt group. Furthermore, the fact that the learning dealt with in this study is learning which results in the formation of new sensory patterns may likewise sound like material already well worked over by Gestalt psychologists Their interpretation of learning as a matter of "perceptual reorganization" or of "re-Gestalting" might make it appear that they already have stressed the sort of material here presented.

However, a rather odd situation prevails in this respect. Although the material of this study is intimately related to the work of Gestalt psychology—one might say accurately that it grows directly out of the Gestalt work—the Gestalt psychologists have given so little attention to this form of learning that some psychologists of other schools [see Braly (2) for example] have accused them of denying the existence of such learning However, the fact that Gestalt psychologists have given too little attention to this form of learning cannot be attributed to any lack of knowledge on the part of Gestalt psychologists, but must be explained by reference to the psychology of controversy. In their studies of sensory organization, Gestalt workers have had abundant opportunity to observe the dependence of sensory organization on training. A naive subject, for instance, can see but one of the possible organizations of many of the reversible illusions. A naive subject hears a chord as a unit—it is only with training that he can get a different sensory organization from the stimulation, etc. However, in their discussions of learning, the Gestalt psychologists hardly utilize such material at all. When they talk of learning as a matter of perceptual reorganization, their examples indicate, almost without exception, that they mean by this a change in associated or redintegrated meaning. For example, when Köhler's chimpanzees learned to utilize boxes to reach suspended food, the change was one that could properly be called "perceptual reorganization," since perception is a broad term covering associated meanings as well as direct sensory experience, but the change was not one that could have been called "sensory reorganization."

By the above, I do not mean to imply that Gestalt psychologists have failed to relate their work on sensory organization to the problems of learning. Sensory organization is assigned a place of fundamental importance by them as a factor determining the ease or difficulty of the discovery of solutions or relationships, and by their experimental work they have given abundant proof that this emphasis is warranted. Similarly, with regard to the question of what stimuli will serve to re-arouse established habits, they stress the fact that the important consideration is, not whether the stimulus has some of the absolute properties of the original situation, but whether it has an organization or pattern more or less analogous to that of the original situation or to some relatively independently segregated portion of it. However, the relation which they recognize between sensory organization and learning is not a reversible relationship, as one might say. The importance of sensory organization for learning is stressed, but they assign only a very unimportant rôle to learning as a basis of sensory organization. Thus, Köhler gives the opinion:

> It may be that in a very *unstable* constellation, in which a certain form can be seen or organized, past experience of such a form will tend to produce it really, whereas without that previous experience, this would not happen. Even in this case, however, we should still have to explain what factors produced that form in previous life. It is only assumed, then, that conditions were more favorable, and the question remains open whether they were not favorable for its originating directly. In any case, even granting that previous experience of a certain form favors its appearance in the future, we ought to realize

> that such an occurrence will be limited to definite cases, namely those in which the actual constellation does not tend decidedly toward other more stable wholes and forms. (7, pp. 208-209)

This skepticism on the question of whether sensory organization can result in any appreciable amount from training may be traced primarily, I believe, to the fact that the Gestalt psychologists have received such strong opposition from other psychologists on this very topic. The Gestalt psychologists have become convinced by their work that spontaneous dynamic organization of psychological processes is a basic phenomenon. Their opponents, however, have generally taken the stand that such organization is a product of past learning or experience, and consequently is not one of the primary data of psychology. The self-confidence of this opposition, it must be admitted, has not grown from any experimental evidence directed specifically at the principles which Gestalt psychology has advanced, but has sprung rather from a strong faith in the strength of the empiricist position in general. This confidence is not altogether surprising, for the empiricist or associationist doctrine has had some notable victories in its long career. First of all, it banished rationalism as a basic method of approach in philosophy. Later it outstripped apperceptionism in the (quite unconscious) race for incorporation into the developing field of experimental psychology. And in relatively recent years, it has helped to force a more critical and scientific approach to the problem of instinctive behavior. Because of the self-assurance thus engendered, the associationists have not hesitated to apply their familiar formula to the new material unearthed by Gestalt psychology. Dashiell, for instance, to quote an extreme example, suggests that probably it is past experience which determines the fact that we see "moving pictures" as moving (3, pp. 404-405).

Naturally, such a determined and dogmatic opposition has led Gestalt psychologists to minimize the evidences of the operation of learning in determining sensory organization, and to stress all of the evidence indicating that sensory organization is the result of spontaneous organizing tendencies of the nervous system. From the experiments of Gottschaldt (4, 5), for example, the thing which they have stressed is, not that training in some cases made it possible to get a sensory organization from his figures which ordinarily would never have stood out, but the fact rather that the organization of the total figure tended to prevent the separate perception of the logically separable part. One can find in the writings of Gestalt psychologists, if one is interested in the search, various statements indicating their familiarity with the fact that training, set, attitude, etc. help to determine the sensory organization of at least some materials. It is true, moreover, that they describe learning as a matter of perceptual reorganization However, as noted before, almost all of their examples of learning can be described as cases of changes of meaning—cases where the subjects learn to associate with the sensory material certain other things not sensorially given

To sum up, then, it may be said that although the sort of learning investigated in the present study is closely related to Gestalt materials, it is not a sort of learning which they have stressed. Quite on the contrary, their position, as well summarized in the above quotation from Kohler, is that learning will be a significant factor in determining sensory organization only in relatively rare cases when the organization naturally is unstable

However, if we turn now from the Gestalt psychologists and ask whether their opponents have done any better in the matter of *giving a place in the field of learning to the matter of sensory organization*, we find that the material is quite as much neglected. The chapters on perception, in books of the associationist tradition, repeat over and over the dogma that sensory organization comes from past experience, but when one passes on to the chapters on learning, it seems that such material has been forgotten or discarded, and one finds discussions of learning in terms of stimulus and response connections, in terms of associations of ideas, in terms of redintegrations of meanings, etc., but no records of experiments with sensory organizations due to training

The recent and very interesting suggestion by Thorndike (11, pp 338-345) that increase of identifiability of the stimulus is one of the special phases or aspects of learning is one of the discussions which comes nearest to recognizing the sort of learning involved in the present study However, in his discussion of how greater identifiability is secured, Thorndike clings to his connectionist principles, rather than recognizes the phenomenon of development of sensory organizations

It was this lack, then, on the part of both of the contending groups that led to the present investigation The study aims to explore part of the territory of this field of sensory organization in order to discover whether sensory organizations sometimes develop in a way, and persist with a permanence, which would demand their inclusion in the field of learning as a definite part thereof It is hoped that this preliminary investigation of such material may pave the way for studies of such learning on many different scores. I might, at the present, comment on only one characteristic of this material which illustrates the point that different portions of the field of learning will obey different principles As has been clearly shown with some other forms of learning, motivation is sometimes indispensable for the utilization of habits. However, as the reader can very easily demonstrate for himself with the experimental materials of the present study, motivation is not needed at all to secure the utilization of such habits as are involved in the present study

The Experiment With Incomplete Figures

The first division of the experimental work of this report concerns an experiment with the incomplete or fragmentary visual figures shown in Figures 1 and 2. The experiment demonstrates that with such material as this there is a process of learning which results in habits which have a high degree of permanence. Some of the incidental observations of the experiment throw light on the question of how such habits are formed, and suggest a very tentative theory on the nature of the nervous processes involved.

The suggestion for this first experiment came from Gardner Murphy's discussion (8, pp 283-287) of a study by R. F. Street (10) The original study by Street was not intended at all as a study of learning, but as a study of a certain type of intelligence-test materials Street was interested in the question as to what correlation existed between the ability to complete such fragmentary visual figures and ability in ordinary verbal completion tests[2] Gardner Murphy, however, refers to Street's materials for an altogether different purpose, namely, to illustrate his suggestion that much of complex learning may be interpreted as a matter of perceptual reorganization When Murphy's book appeared, the second experiment of this paper had *already* been conducted The new material which *Murphy* mentioned seemed, however, to have interesting possibilities as a means

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[2] It may be worthwhile to call attention to a fact which Dr Kluver brought to my attention, that Street's study has some resemblance, in the materials used, to the earlier studies by van der Torren (12) and the Schobers (9), using some test materials first suggested by Heilbronner and used by him in 1905 for the study of psychiatric cases Their figures, however, were line drawings in which the full outer contour was given, but in which many of the finer details were omitted in the more difficult figures It is interesting to note that with such figures children showed, with increasing age, a definite increase in ability to identify the figures. With his material, on the other hand, Street found the children in the 3rd, 6th, and 9th grades all made approximately the same average score

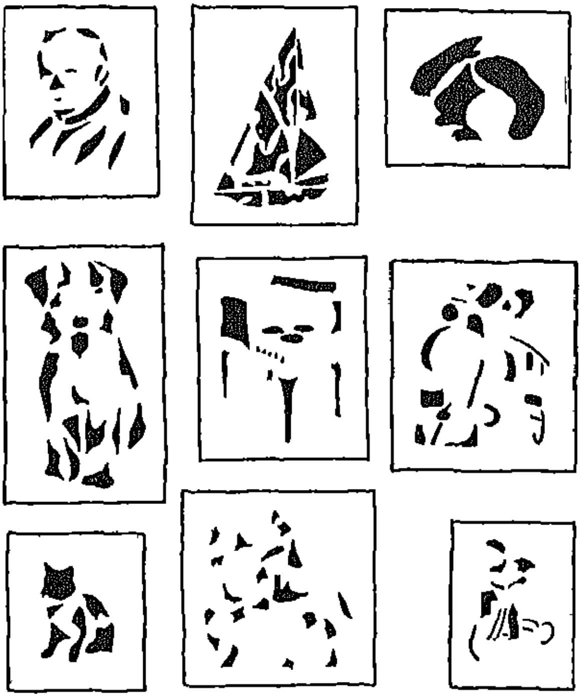

FIGURE 1

Nine Figures from R. F Street (10) Used in the First Experiment

The figures are arranged in the order of their presentation in the first and second testing periods. The figure presented first is the upper left-hand figure, the second figure the one below it, the fourth figure the one at the top of the second column, etc The fourth figure is an adaptation of one of the simpler of Street's figures, the other eight are reproductions of his figures.

(From R. F. Street's *A Gestalt Completion Test*, 1931, by permission of the publishers, the Bureau of Publication, Teachers College, Columbia University, New York.)

of investigating further some of the problems that had already been dealt with, and consequently, this further experiment was conducted. Although second in point of time, this experiment with incomplete figures is reported first in this article because the procedure and results are somewhat simpler than those of the other experiment.

Experimental Materials and Procedure. Figures 1 and 2 show the 19 complete figures used as the main stimulus materials in this experiment. As indicated, 8 of these figures were taken from Street's collection, one was an adaption of one of his figures, and the other 10 were new figures constructed on the same principle as Street's figures.

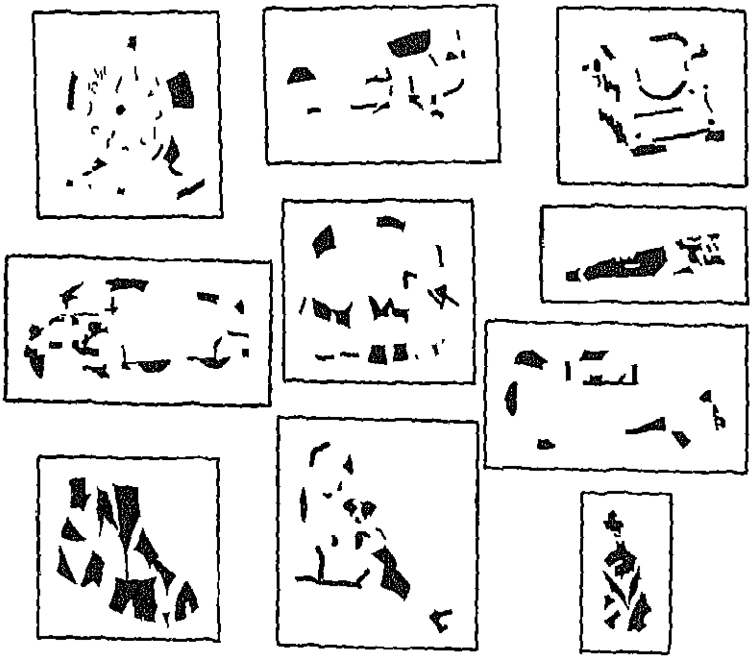

FIGURE 2

ORIGINAL INCOMPLETE FIGURES USED IN THE FIRST EXPERIMENT

As in Figure 1, the above drawings are arranged in the order of presentation in the first and second testing periods, the above drawings being presented as the 10th to the 19th drawings in the series

The experiment was conducted as a group experiment, the figures being exposed on a screen by means of an opaque projection lantern. From 9 to 24 subjects were tested at a time The size of the projected image was 55" x 55" in the case of the drawings which most completely filled up the illuminated portion of the screen A rough idea of the exposure conditions may be secured from the fact that when the machine was used to project single-spaced typewritten material, a block of typing six inches across and six inches high could be projected on the screen with sufficient clearness that the words could be read in the farthermost corner of the room, although isolated typographical errors could not have been detected Since the detail in the different figures was not nearly so fine, the subjects had no difficulty in seeing the figures clearly, especially since they were allowed to choose whatever position in the room gave them the clearest vision It might be mentioned incidentally at this point that a comparison of the scores with the positions of the different subjects in the room seems to indicate that the factor of distance from the screen did not have any appreciable influence, if any, on the results.

Four different groups of subjects were used. All of them were summer school students at the University of Arkansas. One of these groups was a control group used as a check on the delayed-recall test given the other three groups. This control group was tested only once, and then with the very brief exposures used in the delayed-recall tests given the other groups The other three groups were each given three different tests, the first two of which were separated by exactly one day, and the second two of which were separated by 22 to 25 days.

The further details of the procedures used with the three main groups are as follows: *On the first test,* before any of the figures were shown to a group, instructions were first given them covering the following points.

> You will be shown some figures which can be seen as well-unified and coherent pictures of certain familiar things, provided you "fill in," as it were, the spaces between the fragments shown In case you see the correct picture, all of the different marks in each drawing will be seen as belonging to the completed figure In case you get a pattern which does not utilize all of the fragments, you can know thereby that you have not yet seen the figure intended.

To make these instructions clearer, the simplest figure of all was shown to the group (the first drawing in Figure 1), and the above instructions were repeated with particular reference to this figure Further instructions were then given regarding the recording by each subject on a sheet of paper of what he had seen and when he had seen it. These further instructions covered these points:

> Opposite the number indicating the picture which has been shown, you are to put down one or more words indicating what you have seen in the drawing exposed and, in parentheses, whether you have seen the object clearly and easily, or imperfectly and uncertainly. You are also to mark the approximate amount of time which passed before you saw that object in the drawing exposed The timing will be indicated to you as follows: as you are watching the picture, the experimenter will call off the time at second intervals for the first five seconds, and at five-second intervals thereafter You should record the last time called before you saw the object which you record.
>
> After you have secured one organization of the picture, and have jotted down the items asked for above, continue to observe the picture for the full exposure period In case you see something different during the remaining time, record what is seen, when it was seen, and whether it was seen vaguely or certainly.

Since the various figures were of quite unequal difficulty, the length of the exposure time was varied from twenty seconds for the easiest figures to as much as three minutes for the most difficult. After each figure had been shown, no explanation was given as to what had been represented, and the subjects had been asked also to refrain from comments to one another. At the conclusion of the exposure of all 19 of the figures, the subjects were cautioned that since other groups were to be tested, and since subsequent tests might be given to the same group, they were earnestly requested not to discuss the work with any other person. The material excited an amount of curiosity which makes it impossible to hope that this request was honored in every case, but I have reason to believe that most of the group cooperated in this respect

The above procedure was the procedure on the first test with all three of the main experimental groups (Groups A, B, and C), with the exception that one of the groups (Group C) was given some further preparation or assistance before each picture was exposed With this group, before each picture was exposed, the group was told what *class* of object would be portrayed. It may be well to list here the descriptions given, together with a brief indication (in parentheses) of the correct answers. The drawings are listed in the order of presentation.

1 (Man's head)
2. An animal (dog, puppy)
3. An animal (cat, dog)
4 A means of transportation (boat, sailboat)
5 A piece of household equipment (stove)
6 An animal and a person (man on horseback)
7 A small land animal (rabbit)
8. A means of transportation (locomotive)
9 A child and a toy (boy and tricycle)
10 A piece of household equipment (alarm clock)
11 A means of transportation (bus, truck)
12. Something used by almost everyone everyday (shoe)
13 A means of transportation (airplane)
14 An animal (elephant)
15 An animal and a person (boy and dog)
16. A commonly-used mechanical device (typewriter)
17 A common tool (saw)
18 A means of transportation (automobile)
19 A musical instrument (violin)

In scoring the papers of all groups, it might be remarked here parenthetically, the procedure followed was naturally that of counting correct any answer indicating the subject had seen the object represented, regardless of whether the specific words used above were given

In *the second testing period,* for all three of the main experimental groups the conditions and procedure were virtually the same as were used with the Groups A and B described above The differences were these (1) the exposure time was shortened in this period, especially for those pictures which had been seen by most of the subjects in the first period, (2) after all of the figures had been exposed, the series was given again, and as each picture was thrown on the screen the group was told what specific object was represented. A good many subjects experienced difficulty in seeing some objects even after they had been named specifically, and consequently the different parts of such objects were pointed out, in order that as many as possible of the subjects might see all of the pictures. On this second test, Group B was given a little additional help toward seeing the figures intended. Instead of merely naming the object represented, and indicating how the different fragments were related to this intended whole, aid was given by exposing the complete drawing from which the fragments had been taken in the case of drawings of Figure 2. Otherwise the second test was the same for all three main groups

The *third testing period*, which followed the second period by 22 to 25 days, was the same for all three main groups and for the control group as well, except that it was necessary to give the control group some special instructions, such as had been given in the first testing period with the other groups, to make them understand what was their task Also the subjects of the main groups were warned that the order of presentation would not be the same as had been used on the previous testings, and that some new figures would be scattered among those previously seen.

In this third testing period, the pictures were exposed for only a very brief time. A shutter tachistoscope had been mounted before the lens of the projection lantern. With the aid of this, each picture was given a first exposure of about .01 second (after a warning signal had been given so that the subjects could get a preliminary

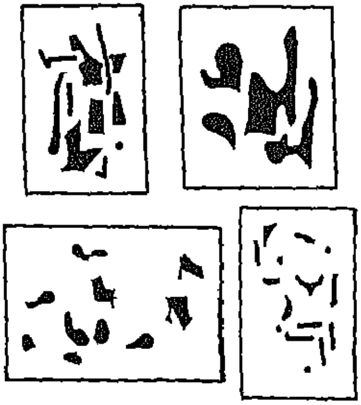

FIGURE 3

FOUR DRAWINGS TYPICAL OF THE NONSENSE DRAWINGS SCATTERED AMONG THE OTHER DRAWINGS IN THE THIRD TEST fixation of the center of the exposure screen) After that briefer exposure for each picture, a second exposure of a full second's duration was given for the same picture. The subjects were asked to indicate what they had seen on each exposure. Most of the 13 drawings which were added to the list on this exposure were nonsense drawings, although no mention of this fact was made to the students. Some examples of these added figures are shown in Figure 3

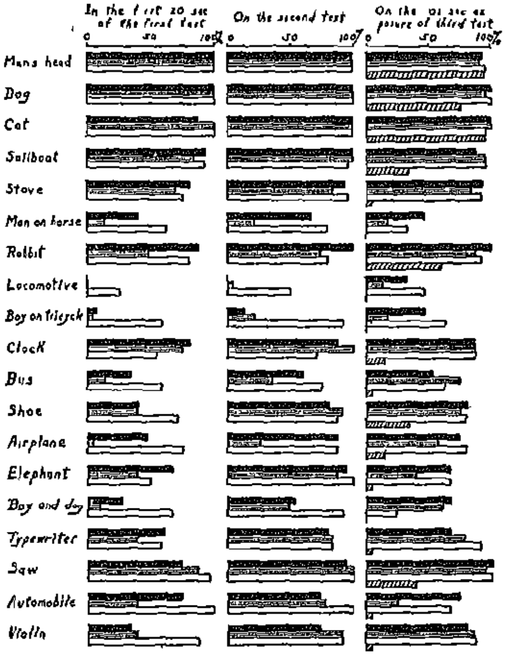

FIGURE 4

PERCENTAGES OF THE DIFFERENT GROUPS SEEING THE DIFFERENT PICTURES IN THE FIRST 20 SECONDS OF EXPOSURE IN THE FIRST TEST, IN THE FULL EXPOSURE ON THE SECOND TEST, AND IN THE FIRST OR VERY BRIEF (.01 SECOND) EXPOSURE OF EACH PICTURE ON THE THIRD TEST

The solid black bars represent the percentages of Group A (N=15—*see* description of procedure for the conditions used) The bars marked with two horizontal stripes represent Group B (N=23), tested with almost exactly the same procedure as used with *Group A* *The white bars represent* Group C (N=24), which was aided on the first test by having been told what class of object each drawing represented The bars marked with slanting lines represent the percentages of the control group (N=20), used *only with the procedure of the third test*

Results. The graph which shows the results of this first experiment most comprehensively is Figure 4 The title and subtitle of this figure explain what data it presents and explain what groups are represented by the different types of bar.

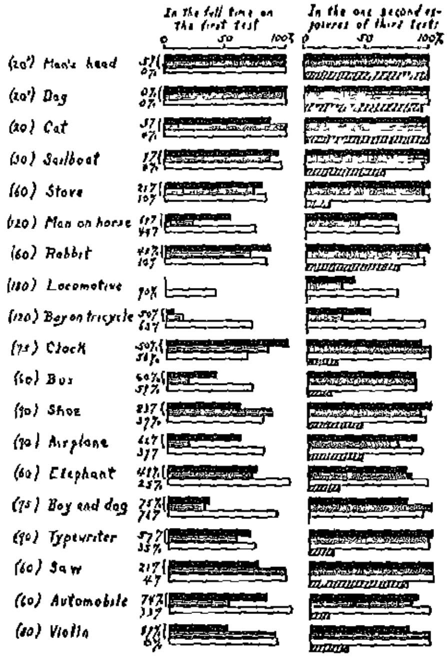

FIGURE 5

PERCENTAGES OF THE VARIOUS GROUPS SEEING THE DIFFERENT PICTURES IN THE FULL EXPOSURE TIMES OF THE FIRST TEST AND IN THE SECOND OR LONGER EXPOSURES OF THE THIRD TEST

For the explanation of what the different types of bar represent, see the subtitle to Figure 4. For the explanation of the numerical entries on the graph, see the text

In Figure 5 are shown some data supplementary to the data of Figure 4. It will be remembered that on the first test the different drawings were not exposed for equal lengths of time, since some were much more difficult than others. The full exposure times allowed are shown in Figure 5 by the numbers in parentheses to the left of the words describing the different drawings. The percentages written at the left of the bars for the first test, in Figure 5, indicate *what percentages of the subjects who saw the drawings correctly on the first trial saw them after the first 5 seconds of the exposure had passed.* (The differences in length of the bars for the first test in Figure 4 and Figure 5 indicate, of course, what proportions of each group saw the various figures after the first 20 seconds of each exposure had passed). In order not to make the record too complicated, the data from Group A and Group B have been combined in figuring these percentages of successes after the 5-second point.

In analyzing the general findings indicated by Figures 4 and 5, the following things may be pointed out.

1. The relative difficulty of the various drawings is indicated best by the left-hand column of Figure 4, which shows the percentages of the different groups recognizing the different pictures in the first 20 seconds of the exposure of each on the first test. However, the data on the scores of the control group (see both Figure 4 and Figure 5) throw light on this same matter

2. The influence of verbal assistance on the difficulty of the task may be seen from the left-hand columns of both Figure 4 and Figure 5. With the more difficult drawings, Group C seems to have been helped in almost every case by having been told what class of object was represented

3. As is indicated by the percentages expressed in numerical terms in Figure 5, in a large proportion of the cases (especially if we exclude the four easy figures shown first), the correct organization was not gotten promptly, but had to be searched for It is especially interesting here to consider the record of the control subjects given their first experience of the pictures under the conditions of very brief stimulation used with the other subjects on the third test. Even on the 01 exposure a number of the control subjects saw correctly some fairly difficult figures. An even larger number was able to see some of the fairly difficult figures on the one-second exposure (on which, of course, they presumably had some aid from the 01-second exposure just preceding) The relatively small proportion of the control subjects who succeeded shows, however, that with most of the drawings the correct organization was not the most natural organization for these drawings

4 The data on the third test for the three main groups show a very firm retention over the interval of 22 to 25 days of no practice. The comparison with the record of the control group shows what a marked influence was exerted by past training. However, the further consideration needs to be taken into account that some of the subjects had not been able to see some of the more difficult figures clearly or at all, even with the assistance given after the second test Consequently, perhaps a fairer measure of the retention of this material is to be secured by calculating the percentage of the subjects who had seen each figure correctly on their own efforts in the second test who saw the same figures correctly on the third test Out of 930 cases in which pictures were correctly named on the second test, there were only 28 cases (or 3%) in which errors were made on the third trial. These data are sufficient to raise the question as to whether there is any other type of habit so efficiently retained as habits of sensory organization.

On the third test there were very few cases in which the subjects applied to any of the regular pictures the name of some other one of the things they remembered were in the series. In other words, there must have been relatively little guessing. This same conclusion is indicated by the reactions to the nonsense figures added to the collection on the third test. In only 18% of the cases did the subjects attempt to say what these drawings represented, and in 59% of these cases they indicated that their perceptions were but guesses. In only 6% of the cases did the subjects apply to a nonsense drawing a name which might indicate that it had been confused with some of the regular drawings seen before. It must be remembered, too, that perhaps most of this 6% represented legitimate attempts at identification of drawings recognized as not seen before. The nonsense drawings probably looked as much like "a car," "a dog," or "an airplane," as like anything else

I might sum up the results of this experiment now in some more general statements It might be noticed, first of all, that the usual process by which one gets to see these figures is a process whereby the figure changes from one organization to another in an all-or-nothing fashion. It sometimes was true that a subject would notice first one detail of a drawing, and then from that gradually assimilate one portion after another of the rest of the drawing until he was able to see the entire unit; but this was seldom the way in which the thing happened. The typical process was that the figure would change as an entirety from one pattern to another—often, at first, the figures looked liked so many jumbled marks, then one unification might appear which was not very satisfactory, but looked possible. Thus, quite a few subjects saw the drawing of the rabbit first as being "fish jumping out of the water," or as "seals" or as "arms and hands" But, since these patterns did not seem adequate, and the examination was continued, the figure would next transform itself, perhaps, into something else, until finally, perhaps, the correct figure was seen It is interesting that once an organization had been achieved, however, even where it was considered by a subject as being clearly incorrect, it was found hard to exclude that organization and see something else I regard even this as one clear-cut indication of the influence of learning with regard to sensory organization It seems as though, with material of this sort, once an organization is achieved, that very fact seems immediately to give a "sticking power" to that organization which tends to block any efforts at reorganization. A "stamping in," as one might say, seems to follow immediately and so naturally that it is easy to overlook the fact of its presence

Another general fact not contained in the graphs above is the fact that there are rather consistent differences in the ability to secure the correct organizations from these incomplete figures This has been determined by correlating the scores from odd and even-numbered pictures in the first experimental period (with the omission of the first drawing exposed) for the 43 subjects who had not received preliminary verbal preparation. The correlation found was .64, which, when corrected for halving of the data, becomes 78 ± 045 This correlation is not appreciably different from the reliability coefficient reported by R F Street for the 13 figures which he employed, but it is a figure which may much more reasonably be termed a reliability coefficient than his calculation could be. For, in calculating the reliability of this material, Street's procedure was to correlate the scores made on a first exposure of his material with scores made on a retest with the same material after about a month's time. In view of the extremely firm retention of such learning material, it may easily be seen that Street's two testings must have lacked almost completely the independence which is one of the indispensable conditions for calculating reliability coefficients His correlation probably would have been higher than mine if it had not been for the fact that his test was only 13 items long, and that, moreover, certain of his figures were so easy and others so difficult that for all practical purposes his test was even shorter than this.

Theoretical comments on this experiment. These findings suggest a number of principles. In the first place, this experiment seems definitely to establish that sensory organizations may be developed by experience. Second, such sensory organizations, even though achieved only with considerable difficulty in the first instance, are retained with extremely great efficiency and can function even under conditions of very brief stimulation. Third, such sensory organizations are not secured simply as a result of previous training and of present sensory stimulation The securing of such sensory organizations may be facilitated by ideational processes, or association chains set up by verbal stimuli This particular fact is one which seems to me to be of considerable theoretical interest, for it seems to prove that the pattern of dynamic stresses which, let us assume, operates spontaneously to hold in place the nonsensical sensory organization which these incomplete figures first tend to assume is subject to weakening and modification by complex thought processes. I am inclined to believe that the process involved may best be thought of in some such way as this, that the task of seeing the correct figures in these incomplete figures is a process of conflict and interaction in the nervous system between the spontaneous organizing factors and the redintegrative patterns, with their own tendencies of stress and closure, which have been derived from the past experience of the person. These habit-derived organizations can win out over the spontaneous organizing influences by various means, as: (*a*) perhaps the same causal process operates here which Kohler has suggested (7, pp 185-186) as a possible explanation of the phenomenon of reversible illusions—after one organization has dominated the central processes for a while, its relative strength becomes lessened through some process of fatigue, which makes it possible for some other organization to take the field, even though it was less favored originally; (*b*) either because of some instructions that have been given or because the subject notices some detail which suggests this or that total figure, the subject redintegrates some sensory organizations derived from his past experience, which redintegrated patterns then tend, though not necessarily immediately, to cause an assimilation of the present sensory fragments into a new total organization I believe that this latter operation possibly may be envisaged as a process of perceptual overlap, or perceptual superposition, *very probably analogous to the process in a binocular-rivalry situation* It looks as though it may be that in redintegration there is aroused in the brain a pattern of nervous activity which is similar in distribution and in properties of dynamic organization (except intensity or steadiness) to the pattern of central nervous activity set up directly by sensory stimulation.

THE EXPERIMENT WITH AMBIGUOUS FIGURES

The second experiment employed somewhat different experimental materials, but otherwise was similar in many respects to the experiment described above. The subjects, who were all university students, but not the students involved in the incomplete-figure experiment, were tested in groups of from 10 to 32 students at a time As above, the stimuli used were visual figures presented by means of the projection lantern. However, in this case, the stimuli were not incomplete and meaningless at first sight, but were ambiguous figures which almost universally yielded a clear-cut and meaningful sensory organization at the very first glance One of the ambiguous figures used is a somewhat rough copy of the figure "My wife and my mother-in-law," which Boring reproduced (1) from its original appearance in Puck in 1915. The other ambiguous figure, which is not so satisfactory, since the two alternative organizations which are possible for it are not so mutually incompatible, was drawn by myself. For a really satisfactory experiment, it would have been desirable to have had a score or more of such ambiguous figures but these were all that I could secure at the time.

Experimental materials and procedure Three different experimental procedures were used with the different groups of subjects in this experiment With the first group of subjects, the visual stimuli were presented without any preliminary preparation of the subjects, except that they were told they were to be shown a pen and ink drawing which they were to examine carefully for a 15-second exposure, and which they would be asked to describe in writing at the completion of the exposure With the second group, the subjects were given a verbal preparation which might have been expected to favor one or the other of the possible organizations of the ambiguous figures which were to be seen. With the third group, the procedure differed from the first condition described in that the groups were given special perceptual preparation rather than special verbal preparation, as under the second condition.

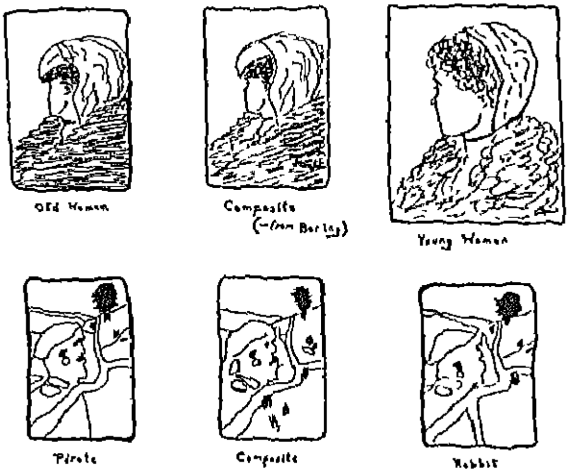

FIGURE 6

THE FIGURES USED IN THE SECOND EXPERIMENT

The two ambiguous figures occupy the center positions; the drawings on the sides are the "single-phase drawings" used with the perceptually prepared subjects.

(From E. G Boring's "A New Ambiguous Figure," *Amer. J. Psychol.*, 1930, 42, p. 444, by permission of the author and the editor)

The more exact description of the procedure must be described separately for the different experimental groups. With the subjects given no special preparation for the viewing of the ambiguous figures, the subjects were simply told, as was mentioned above, that they were to examine the drawing exposed on the screen, and at the conclusion of the exposure to write down as complete a description as possible of what they had seen. The young woman-old woman composite was then shown for 15 seconds, and following that the subjects were allowed a period of about two minutes to record their descriptions of what they had seen. When this writing was finished, the same picture was again given a 15-second exposure, and the subjects were then asked to record any further facts which they had not noticed and recorded in the first case. Finally, still a third 15-second exposure was given, and a third period was given for adding to the previous descriptions. Following these three exposures of the first ambiguous figure, the same routine was followed with the other composite picture, the rabbit-pirate composite. When the three exposures and three recording periods had been completed with this composite, the subjects were asked to speak up and tell what they had seen in the last picture shown. With most of the groups, both of the possible organizations would be mentioned by members of the group. Where all subjects had seen only one organization, however, the experimenter told them what other object might be seen in the picture. Such comments naturally aroused the curiosity of the subjects who had not succeeded in getting both of the possible organizations. (I might mention, incidentally, that in both of these experiments there was no difficulty in getting strong motivation for the work—possibly partly because of the materials and partly because of the rivalry inherent in a group situation). The subjects were then told that the last composite exposed would be exposed again for a two-minute period, that they were to try to see the other possible organization during that time, and that they were to keep a record of the point in time at which they secured the other organization. The timing was done, as in the experiment described above, by my calling out the time in second intervals for the first five seconds, and in 5-second intervals for the remainder of the exposure At the end of this long exposure, some further assistance was given before the second long exposure. This further assistance consisted of showing for 15 seconds the single-phase drawing stressing the organization which the subjects were having difficulty in seeing. (With some groups, both single-phase drawings had to be shown). Then the composite was shown for another two-minute period In some cases some subjects were not able to reorganize the composite even with this help. In such cases the single-phase drawing was shown for another 15 seconds, and the composite shown for a sixth and last time. After this series of later trials with the rabbit-pirate composite, the same course was followed with the young woman-old woman composite.

The procedure used with the perceptually prepared groups was exactly similar to the above, except that before the *first* exposure of each composite, the subjects were shown one or the other of the single-phase drawings derived from that same composite A 30-second exposure period was allowed for this After this exposure the subjects recorded their descriptions of this picture. No intimations were given that the picture first shown was related to the picture which they were told would be exposed next, and which they were told they would be expected to describe. The subjects working under this condition of preliminary perceptual preparation were divided in two sections. One section viewed the single-phase drawings portraying the old woman and the rabbit respectively; the other section was shown the single-phase drawings portraying the young woman and the pirate respectively.

The procedure used with the verbally prepared groups was exactly similar to the first procedure described above, except that before each composite was shown, the subjects were given a description calling attention to the characteristics of one of the possible pictures of the composite. These verbal descriptions were read aloud twice immediately before the composite was shown One section of this verbally prepared group listened to the following description of the first composite:

> You will be shown a pen and ink drawing of a young woman's head. The head is not only turned to the side, but, in fact, is turned so far around that the young woman's cheek hides her mouth, eyes and most of her nose, so that one can see only the small tip of her nose and her eye-lashes Her left cheek and ear are clearly visible, as is also the curve of her chin Her mouth and eyes, however, cannot be seen. A heavy fur collor is around her shoulders, and on her head is a hat with a veil flowing from it back over the back part of her head.

Before the rabbit-pirate composite was shown, this same section listened to the reading of the following description:

> The central feature of the second drawing is a man's head The man has somewhat the appearance of a pirate, with an ear-ring in his ear, a heavy mustache, rather rough face, and a cap or beret on his head The head is turned to the side, so that one sees the profile of the man's face Across the man's chest there seems to run a crooked branch of a tree; or it may possibly appear that the head has merely been added to a draw-

> ing which, but for the head, would have been the drawing merely of some hills with a path wandering down one of them, with a tree in the distance, etc

The other section of the verbally prepared subjects listened to descriptions favoring the other possible organization of each composite. For the first composite the description was:

> You will be shown a pen and ink drawing of an old woman's head The head is turned to the side, so that you will see the face in profile The woman has a large Roman nose, rather shrunken lips, and a rather protruding chin almost hidden in the heavy fur collar of her coat. Her left eye is clearly visible, but her ear, most of her head, and even part of her cheek are *covered by a scarf thrown over her head.*

For the second composite the description was

> Now you will be shown a second drawing. The central feature of this drawing is a rabbit sitting up on its hind legs by the side of a path which wanders up the hill behind the rabbit. The picture contains other minor details, such as a tree in the background, several hills in the distance, a few rocks scattered about close to the rabbit, and a few clumps of grass near the path The rabbit, which is seen from the side, looks as though it were perhaps holding some object in its fore paws.

Results. As an examination of the procedure will have indicated, the experiment was calculated to yield results on two questions (1) what are the influences of prior perceptual and of prior verbal preparation on the seeing of such ambiguous figures? (2) how easy or how difficult is it for subjects to alter their organization of such a figure, once they have been led to see it in one way or the other?

Figure 7 indicates the results of this experiment insofar as they bear on the question of the factors governing the organization which tends to be secured first From the groups given no special preliminary preparation, which may be regarded as control groups, it may be seen that the two possible organizations of each composite did not seem to be equally easy to secure Thus, with the old woman-young woman composite, 65% of the subjects saw the young woman and only 35% the old woman. With the rabbit-pirate composite, 73% saw the pirate only, 12% saw the rabbit only, and 12% saw both of the possible organizations In other words, these ambiguous figures were not evenly balanced—in each picture one of the possible organizations tended to prevail over the other. But now, when we

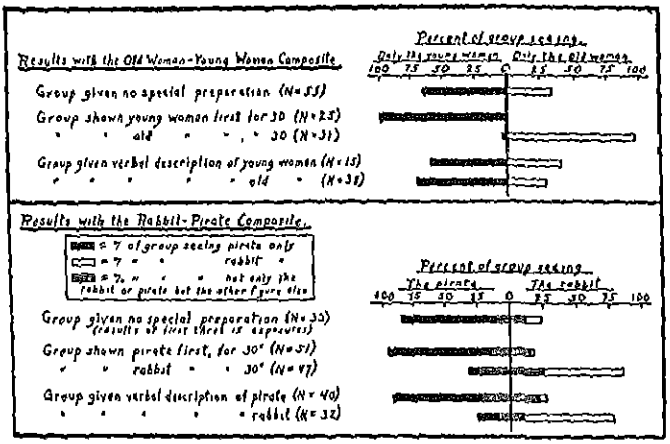

FIGURE 7

Results of the First 15-Second Exposures of the Ambiguous Figures to Groups Given Different Sorts of Preliminary Preparation

The number of subjects in each group is indicated on the graph. Attention is called to the fact that the portions of the groups represented by the striated segments of the bars are represented twice, appearing on both sides of the 0% line.

turn to the results with the groups given a preliminary perceptual preparation, we find that the prior experience of the single-phase drawings controlled almost entirely the subsequent organization of the composites. Thus, of the group which viewed the single-phase drawing favoring the young woman, not one subject saw the old woman in the composite, even though there are quite a few differences between the single-phase drawing of the young woman and the picture of the young woman in the composite. And of the subjects shown the single-phase drawing of the old woman, only one subject in 31 saw the young woman rather than the old woman in the composite. Somewhat similar are the results with the rabbit-pirate composite, although the influence of prior perceptual preparation is not quite so clear-cut with this figure. After the single-phase pirate had been shown, about 96% saw the pirate in the composite (though in this case they did not see *only* the pirate in all cases, as 16% of the total group were able to see the rabbit as well, in the composite).

Only 2% saw only the rabbit. When the single-phase drawing of the rabbit had been shown beforehand, 26% of the group saw both figures in the composite, 60% saw the rabbit alone, and 6% saw the pirate alone.

In the case of the groups given preliminary verbal preparation, however, the results were not the same for the two composites. As Figure 7 shows, the preliminary verbal preparation determined the subsequent sensory organization of the rabbit-pirate composite *almost* as effectively as the preliminary perceptual training had done with the other groups. But in the case of the young woman-old woman composite, there is no indication at all that the verbal preparation influenced the sensory organization secured when the composite was shown. With the group that had listened to the description of the young woman, the percentages seeing the old woman and the young woman respectively were almost the same as in the case of the control group given no preliminary preparation. Of the subjects who had listened to the description of the *old* woman, a somewhat larger percentage saw the *young* woman, and a somewhat smaller percentage saw the old woman than was the case either with the control group or with the group that had heard the description of the young woman. It is somewhat of a puzzle as to why this difference appeared in the effects of verbal preparation for the two composites, and in the absence of any experimental evidence it is not possible to say with certainty what factor may be the more important. One factor which very possibly had some rôle was that the rabbit-pirate drawing was not of such a nature that either the rabbit or the pirate would necessarily appear as soon as the picture was seen. Frequently the subjects had to examine this drawing for some seconds before they could discern either of these figures in the composite (and some subjects, especially in the unprepared group, did not see either figure in the full 15 seconds of the first exposure of the composite). This fact gave more time for the verbally aroused redintegrations to exert an influence; so that here we probably have a situation somewhat like that existing with the incomplete figures of the first experiment, in which it was found, it will be remembered, that telling the subjects the general class of object represented helped them to achieve the correct sensory organizations. With the young woman-old woman composite, on the other hand, with almost every subject this figure tended to yield one or the other of the possible organizations in the first instant that the subject viewed the composite. Whatever the factors were that determined such an instantaneous sensory organization, they do not seem to have been processes aroused by the verbal preparations given beforehand. Still another reason why the verbal preparation may have been effective with the rabbit-pirate composite and not with the young woman-old woman composite is very probably this, that the descriptions given of the rabbit and of the pirate aroused redintegrated patterns of quite different nature; whereas in the case of the descriptions of the young woman and old woman respectively the verbally aroused images, as one might say, may not have been well differentiated.

A second aspect of the results with these composite figures concerns the question of whether the achieving of one sensory organization or the other resulted in a habit which would tend to dominate the later organization of the composites. The material discussed above, on the question of the influence of different kinds of preparation, may be considered to have contributed some positive evidence on this question, since the carry-over from the single-phase drawings to the composites was so marked. However, there is some additional material on this question from the series of exposures of each of the composites. For, we can assume that, aside from the influence of learning or of set, one would have expected that as the subjects continued to gaze at these composites they would tend to see the other of the possible organizations However, this proved very difficult for the subjects With the young woman-old woman composite not a single subject secured a different sensory organization of the composite in the first three 15-second exposures of it And in the case of the rabbit-pirate composite this same tendency was revealed, though not in the same extreme degree. Thus, of those who had had no preliminary preparation, 12% were able to see both figures in the course of the first three exposures of the composite. Of the groups given a preliminary perceptual preparation, 49% of those who had seen the single-phase drawing of the rabbit came to see the pirate also in the course of the three 15-second exposures, and 37% of those who had seen the single-phase drawing of the pirate came to see the rabbit also. In the case of the groups given preliminary verbal preparation, 50% of those who had been told about the rabbit came to see both the rabbit and the pirate, and 33% of those told about the pirate came also to see the rabbit.

The same difficulty in changing the sensory organization was seen very clearly in the longer exposures that followed. As was stated above, before the first of these longer exposures the subjects were told what the two possible organizations of the figure were. Before the second of these longer exposures, and before the third also, the single-phase drawings were exposed for 15 seconds each. Even with these aids, however, the subjects only gradually accomplished the task of seeing the other possible figure in the composites, especially with the young woman-old woman composite. Even after they had been told that there was a young woman to be seen, with her head turned partly away, 80% of those who had previously seen the old woman could not see anything else in the first of the two-minute exposures The single-phase drawing of the young woman was then shown them, but even after viewing it, 29% of these subjects still did not succeed in seeing the young woman in the next two-minute exposure *In the case of the subjects who had seen the young woman* at first, somewhat the same difficulties were experienced, but not to an equal degree A rather odd thing in this connection is that frequently, although the subjects reported details of the pictures which were inconsistent with the organization they had secured, they did not see the other possible organization Thus, some subjects reported that on the old woman's nose was a wart (the nose of the young woman, in other words), but they did not see the young woman. Others said that the neck of the young woman looked peculiar, that there was a marked swelling on it (the chin of the old woman) and had a gash in it (the old woman's mouth), and yet they did not see the old woman

However, this above material does not answer in an altogether satisfactory manner our question as to whether learning occurs with such material as this, for the nature of the situation was such that it may well be claimed that the results indicate the operation of set rather than of habit Of course, this objection itself is not a perfectly clear one, because the phenomena of set and of habit are certainly not devoid of relationship I believe it is quite safe to say that "set" is, in part at least, a matter of learning However, it may be that set is something more than habit, and there may be certain functions which can be performed by set which cannot be performed by habit This source of uncertainty in the interpretation of the above results led to the testing of another group of subjects with a procedure rather different from that described above. The subjects of this last group were tested individually in my office. Moreover, the composite picture was exposed to them, not on the screen by means of the projection lantern, but merely as drawings on sheets of paper. Some effort was made to find whether different means of preparation or of exposure of the composite would determine the organization of each composite. Some of the subjects were prepared by reading to them the verbal descriptions of one of the possible organizations or the other. With still other subjects no preliminary preparation was given, but the picture was exposed in a manner which I thought might favor the one or the other organization. For this purpose, two pieces of paper had been cut in such a manner that they might be placed with a small opening appearing between them and so that, as the slips were drawn apart, the drawing behind would be seen through a diamond-shaped opening of increasing size With some subjects the small opening (about ¼ inch across) was placed so that the subjects could see, through it, a portion of the composite which belonged to only one of the two organizations. Thus, certain subjects had shown to them in this manner the nose of the young woman, or the eye of the pirate, or the mouth of the old woman, or some similar part. After a fixation had been assumed, with some of the subjects the two sheets were snatched to the sides as swiftly as possible, while the subject meanwhile continued to gaze at the picture, and described what he saw. With other subjects the two sheets of the screen were drawn apart rather slowly, so that the entire drawing was uncovered in about two to three seconds. By means of these tests I hoped to get some insight into the question of what factors dictated what organization was secured by the subjects who had no special preliminary preparation. One hypothesis that naturally had suggested itself was that some subjects tended to see one organization and other subjects tended to see the other one because they had points of fixation which led them first to notice details which would be consistent only with one total organization or the other. However, the results of this special test were quite inconclusive. The slow withdrawals of the paper yielded exactly the same percentage who saw the organization which I had not intended to favor as who saw the one I sought to bring out. With the quick jerking away, there may have been some tendency to see the picture which included as a consistent part the detail which had been fixated, but the group was too small to have any significance.

However, my main interest in this group of individually tested subjects does not concern this question of the factors influencing the original impression, but concerns rather the contribution of this group to the problem of the rôle of habit in determining the organization of such figures. The manner in which this group was used to get light on this question was this: at a time 12 to 14 days after the subjects had seen these drawings, the young woman-old woman composite was shown to them suddenly, and in an altogether different setting, and they were asked immediately to indicate what they had seen in the composite. This delayed test was given in the midst of an ordinary class discussion The projection lantern was being used to display some pictures of special types of mental defectives. In the midst of this discussion, without warning, the young woman-old woman composite was flashed on the screen The exposure of this picture was brief—about a second or less in time—and the subjects were asked then to take paper and write a description of what they had seen. It is interesting that in only one case out of a total of 19 subjects did the sensory organization appear in a different form than had been achieved previously, and then only momentarily before the same organization appeared as had been seen before Certainly in this test the influence of set can be ruled out as a determinant, since the time that had elapsed was so long and since the physical and psychological setting of the exposure was so changed from that used in the first experience of the figure

Interpretative comments. Most of what has been said previously, in commenting on the results of the first experiment, seems to apply to the second experiment as well This second experiment, like the first, shows that when a sensory organization once has been achieved, whatever the factors that have produced it, there seems to be some sort of cohesive force, as one might say, that tends to prevent the person from securing any different sensory organization. This cohesive force seems to be not merely a matter of set, but a matter also of rather permanent habits Verbal preparation, in the sense of descriptions of possible organizations of the material, seems to be of some value in helping the subjects to organize or reorganize their perceptions, but such verbal preparations seem to be a rather frail governing factor in comparison with the way some other influences, whatever they may be, tend to dictate the organization when the stimuli first are presented. These main governing factors would hardly appear to be constitutional factors or any habits necessarily of long standing in the person's life, because the preliminary perceptual preparation seems able to dominate very readily. But, whatever the influences are, once an organization is achieved, it tends to stick The verbally aroused redintegrations are able, in perhaps most cases, to aid in the reorganization of the sensory material, but their work is against odds The effectiveness of the prior perceptual preparation gives powerful evidence against the theory that thinking is carried mainly in verbal terms, for after viewing the single-phase drawings, the subjects probably could not have given as complete an account as the verbally prepared subjects could have given from the descriptions read them. The descriptions that they wrote down of the single-phase drawings were generally not descriptions (at least in the case of the young woman-old woman composite) which would have differentiated very adequately between the two possible organizations of the composite.

SUMMARY

This paper reports two experiments on the development of sensory organizations by training It indicates that the achieving of sensory organizations is facilitated by verbally aroused redintegrations to some extent, and by preliminary perceptual preparation to an even greater extent. The results indicate that, once one of the possible organizations of visual material has been achieved, this fact seems to operate immediately to render difficult the achievement of any other of the possible sensory organizations which such material might yield. Moreover, once a sensory organization has been achieved, it seems to be retained very efficiently over considerable periods of time, thus justifying the term "habits of sensory organization."

In studying these problems, two different types of visual stimuli were used. The first experiment utilized incomplete figures which tended to yield rather stable nonsensical patterns at first, but which could be seen as well unified pictures if a person, on the basis of his knowledge of the object represented, "filled in" properly the spaces between the portions of the objects that were directly portrayed The material used in the second experiment consisted of two ambiguous figures each of which was capable of yielding two different, but incompatible, meaningful pictures.

In the discussion of the theoretical significance of the findings, attention is called to the fact that such learning as is considered here has been rather generally neglected, both in theoretical discussions of learning and in studies of the factors influencing the rate of learning, the rate of forgetting, etc. The different theories of learning, despite their differences of terminology and emphasis, really appeal to somewhat similar specimens of learning to justify their claims. The psychological group which has dealt most with the sort of learning here exemplified is the Gestalt group, but unfortunately their discussions of learning have given almost no place to such learning because of their strong tendency to emphasize the origins of sensory organization in the spontaneous organizing properties of nervous action Other psychological schools have generally *maintained very dogmatically that sensory organization*, insofar as it is a fact, is a product of past training. Their development of this idea, however, has been restricted almost entirely to discussions of perception, and has generally been forgotten when the discussion turned from that topic to the topic of learning.

This investigation is offered mainly as an exploration of a portion of the field of learning which may prove of value as a means of testing the problem as to whether the field of learning is functionally homogeneous throughout its length and breadth, or whether we should be turning our attention to the problem of classifying the materials of learning on the basis of a to-be-discovered hierarchy of functional similarities.

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UNE ÉTUDE D'UNE PORTION NÉGLIGÉE DU CHAMP DE L'APPRENTISSAGE—LE DÉVELOPPEMENT DE L'ORGANISATION SENSORIELLE

(Résumé)

On rapporte deux expériences sur le développement des habitudes de l'organisation sensorielle La première expérience a employé les dessins fragmentaires montrés dans Figure 1 et Figure 2 Cette expérience a montré qu'il est plus facile d'obtenir l'organisation sensorielle qu'il faut de tels dessins quand on sait bien la classe générale des objets à laquelle appartient chacun des objets représentés, et que, quand on apprend à voir des figures si incomplètes, on obtient des habitudes qui sont retenues d'une façon très efficace. La deuxième expérience a employé plusieurs figures ambigues Elle a montré que la préparation perceptive antérieure est beaucoup plus efficace pour la détermination de comment on voit ces figures que la préparation verbale antérieure, et aussi qu'avec telles figures l'achèvement d'une organisation sensorielle ou d'une autre donne comme résultat la formation définie des habitudes

Les sections théoriques de l'article appuient sur la nécessité d'essayer de savoir comment on classifie les matières du champ de l'apprentissage sur la base de la similarité des principes gouvernants, et condamnent l'essai de découvrir des principes très specifiques qui seront de valeur dans tout le champ de l'apprentissage.

LEEPER

EINE UNTERSUCHUNG EINES VERNACHLASSIGTEN TEILS DES GEBIETES DES LERNENS. DIE ENTWICKLUNG DER SINNESORGANISATION

(Referat)

Zwei Versuche uber die Entwicklung der Gewohnheiten der Sinnesorganisation werden angegeben Bei dem ersten Versuch wurden fragmentarische Zeichnungen, wie in Figur 1 und Figur 2, dargeboten. Dieser Versuch bewies, dass die Erlangung der richtigen Sinnesorganisation solcher Bilder durch die Kenntnis der allgemeinen Klasse der Objekte, der jedes der dargebotenen Bilder angehort, erleichtert wird, und dass das Sehenlernen der unvollkommenen Figuren Gewohnheiten erzeugt, die sehr grundlich behalten werden Der zweite Versuch verwandte mehere zweideutige Figuren Es wurde dadurch nachgewiesen, dass vorangehende Wahrnehmungsvorbereitung viel wirksamer zur Bestimmung ist, wie solche Bilder gesehen werden als vorangehende Verbalvorbereitung, und auch dass bei solchen Figuren die Erlangung einer Sinnesorganisation oder einer anderen eine bestimmte Gewohnheitserzeugung zur Folge hat

Die theoretischen Teile dieser Abhandlung betonen die Notwendigkeit des Versuches, die Materialien aus dem Gebiet des Lernens auf Grund der Ahnlichkeit der herrschenden Grundsatze einzuteilen, und dass man den Versuch verwerfen sollte, irgend bestimmte Grundsatze zu finden, die fur das ganze Gebiet des Lernens gultig sind

LEEPER

THE EXPERIMENTAL MEASUREMENT OF A SOCIAL HIERARCHY IN *GALLUS DOMESTICUS*. III. THE DIRECT AND INFERENTIAL MEASUREMENT OF SOCIAL REFLEX NO. 3

From the Psychological Laboratories of Clark University

Carl Murchison

The first two papers in this series (1, 2) detailed the background of this investigation and presented the methods to be followed in these time and space analyses of social phenomena. A brief abstract of the findings of those two papers is as follows:

> Beginning at sixteen weeks of age six young roosters are arranged in a hierarchy of dominance, the order being determined by the number of individuals in the group that each rooster is able to defeat in physical combat (Social Reflex No. 2). This order of ranking is revised at intervals of four weeks from the 16th to the 36th weeks. Beginning immediately after being taken from the incubator, these same individuals had been tested at frequent intervals in the Social Reflex Runway. This test consisted simply of releasing two individuals simultaneously from opposite ends of the runway, and then observing the time and distance traversed by each in running to the other (Social Reflex No. 1). Various operations involving the concepts of physics were applied without great success to these data. This was followed by the application of the simple measurements of time and space. When plotted as a function of Social Reflex No. 2, it was found that Social Reflex No. 1, plotted in terms of space alone, was almost truly linear. A theoretical correction of the abscissa units, which agreed with the empirical data, satisfied the requirements of linear function.
>
> Social discrimination in *Gallus domesticus* is identified as it is measured in the Social Discrimination Cage. When the discriminations are plotted against Social Reflex No. 2, a relationship appears which approaches a linear form. When the discriminations are plotted against Social Reflex No. 1, true linearity is approximated at the 36th week. The analyses show that male discriminations for pairs of males are away from dominance, and that female discriminations for pairs of

males are in the direction of dominance The constancy of this trait in males makes it possible to measure social discrimination in *Gallus domesticus* in units of space

It was pointed out that these or some similar methods, built upon the presupposition that the methods operate on behavior quanta common to the social conduct of all social animals, can reach through the medium of covariable techniques to the eventual formulation of social law

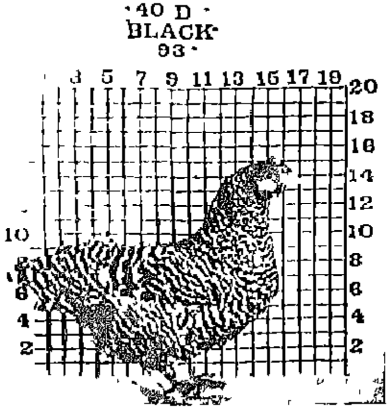


FIGURE 1

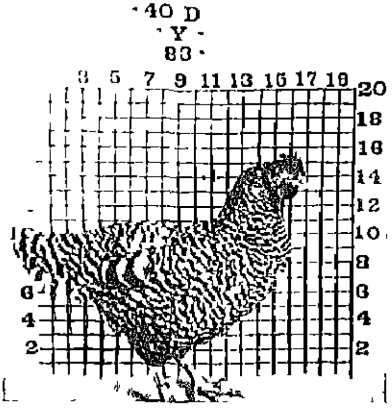


FIGURE 2

THE SUBJECTS

The five pullets that have entered these experiments as members of Group D are pictured in Figures 1-5. These pictures were taken at the 40th week. The coordinates are in inches, and the weight in ounces is given in the legend.

The six male members of Group D have been fully described in the first two papers of this series.

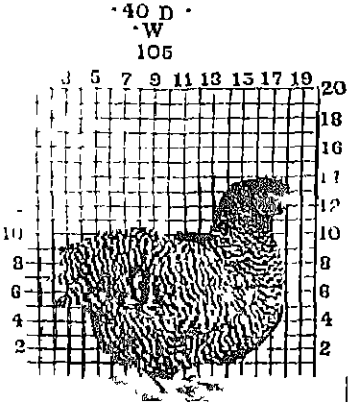


FIGURE 3

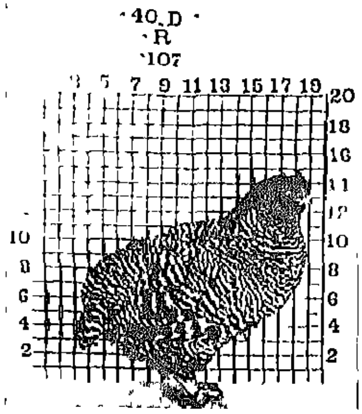


FIGURE 4

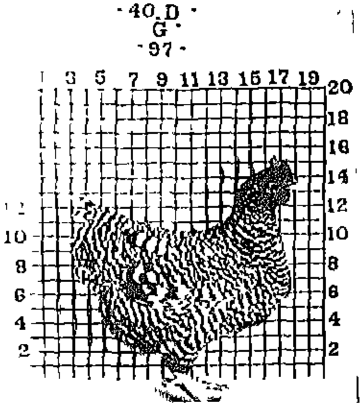


FIGURE 5

The Apparatus

The apparatus referred to in this paper will in all cases be the Social Reflex Runway and the Social Discrimination Cage fully described in the first two papers of this series.

Procedure

At frequent intervals during the period from the 16th to the 48th weeks the treading of these pullets by these roosters was observed and recorded. In each case the identity of the rooster and pullet was recorded. During the earlier months one rooster at a time would be placed alone with the pullets for a period of time, the total time allotted to each rooster being strictly equalized. As the experimenter gained facility in recording the observations, this segregation was discontinued and observations were made on the entire group as a unit.

At certain stated times the pullets were tested in the Social Reflex Runway and in the Social Discrimination Cage. At certain intervals these tests were also made with the pullets and roosters in mixed pairs.

On all data so gathered certain operations were performed, and into these operations were introduced data from the first two papers in this series.

THE RAW DATA

In Table 1 may be found the weight in kilograms of each of the five pullets in Group D at the 32nd and the 40th weeks.

TABLE 1

WEIGHT IN KILOGRAMS OF EACH OF THE FIVE PULLETS IN GROUP D AT THE 32ND AND THE 40TH WEEKS

	32nd week	40th week
P Black	2.49	2.63
P Yellow	2.04	2.35
P White	2.72	2.97
P Red	2.83	3.03
P Green	2.49	2.75

TABLE 2

TOTAL OBSERVED TREADINGS OF EACH PULLET BY EACH ROOSTER IN GROUP D DURING THE PERIOD FROM THE 20TH TO THE 48TH WEEKS. THE ROOSTERS ARE LISTED IN THE HORIZONTAL COLUMN, AND THE PULLETS ARE LISTED IN THE VERTICAL COLUMN

	YY	Blue	Green	Yellow	Red	White	Total
P Black	30	36	0	0	0	40	106
P Yellow	23	40	0	0	0	21	84
P White	33	14	0	0	0	0	47
P Red	29	0	0	0	0	0	29
P Green	25	0	0	0	0	1	26
Total	140	90	0	0	0	62	292

In Table 2 may be found the complete distribution of the 292 treadings that were observed by the experimenter during the period from the 16th to the 48th weeks. It is greatly to be regretted that only three of the six roosters engaged in this reflex. This may be the biological result of the cross-breeding of which these six roosters are the product.

Table 3 indicates the acceleration of time in seconds of Social Reflex No. 3 as compared with Social Reflex No. 1, both measures

TABLE 3

THIS TABLE SHOWS THE ACCELERATION OF TIME IN SECONDS OF SOCIAL REFLEX NO. 3 AS COMPARED WITH SOCIAL REFLEX NO. 1, BOTH MEASURES BEING MADE DURING THE 32ND WEEK. MALE *Gallus domesticus*, GROUP D

	YY	Blue	White
Against other five roosters in Group D	2.7	5.1	5.1
Against five pullets in Group D	2.2	3.1	3.7

being taken during the 32nd week on the three roosters that exhibit *Social Reflex No 3.*

Table 4 gives the average distance and time of each rooster against each pullet in the Social Reflex Runway during the 32nd week Table 5 gives the same data for the pullets paired together in the Social Reflex Runway.

TABLE 4

WITH DISTANCE IN METERS AND TIME IN SECONDS, THIS TABLE GIVES THE AVERAGE DISTANCE AND TIME OF EACH ROOSTER IN GROUP D AGAINST EACH PULLET IN GROUP D DURING THE THIRTY-SECOND WEEK
(Read vertical columns)

	YY		Blue		White		Red		Green		Yellow	
	d	t	d	t	d	t	d	t	d	t	d	t
P. Black	5.48	2.4	5.48	3.1	4.87	3.0	4.87	8.0	2.44	9.1	3.66	6.0
P. Yellow	4.87	2.0	4.87	2.3	4.26	2.4	4.87	3.0	2.44	10.3	3.05	12.3
P Green	5.48	2.2	5.48	4.0	5.48	4.2	4.87	3.4	4.26	11.3	3.66	19.0
P White	5.48	2.3	5.48	4.0	5.48	5.0	4.26	10.0	4.26	12.0	3.05	13.2
P Red	5.48	2.1	5.48	2.2	5.48	4.0	4.87	2.3	4.87	12.0	4.87	9.1
Average	5.36	2.2	5.36	3.1	5.11	3.7	4.72	5.3	3.65	10.9	3.66	11.9

TABLE 5

AVERAGE DAILY DISTANCE IN METERS AND AVERAGE DAILY TIME IN SECONDS RUN BY EACH PULLET DURING THE THIRTY-SECOND WEEK AGAINST THE OTHER FOUR PULLETS IN GROUP D
(Read vertical columns)

	P Black		P Yellow		P Green		P White		P Red	
	d	t	d	t	d	t	d	t	d	t
P Black			2.44	11.2	1.84	27.0	62	25.0	1.84	30.0
P Yellow	3.66	11.2			2.44	26.0	1.84	26.0	1.23	30.0
P Green	4.26	27.0	3.66	26.0			4.26	26.0	3.66	28.0
P White	5.48	25.0	4.26	26.0	1.84	26.0			3.05	15.0
P Red	4.26	30.0	4.87	30.0	2.44	28.0	3.05	15.0		
Average	4.41	23.3	3.81	23.3	2.14	26.75	2.44	23.0	2.44	25.75

Table 6 gives the social discriminations of the roosters for the pullets in the Social Discrimination Cage, while Table 7 gives a simple analysis of the discriminations

The social discriminations of the pullets by the pullets are given in Table 8, with a simple analysis in Table 9.

In Table 10 are given the sex discriminations of roosters for mixed pairs in the Social Discrimination Cage, while Table 11 carries a simple analysis of such discriminations

TABLE 6

SOCIAL DISCRIMINATION OF PULLETS BY ROOSTERS IN GROUP D DURING THE TWENTY-EIGHTH TO THIRTIETH WEEKS. EACH PAIR IS REVERSED FOR A SECOND DISCRIMINATION

(The pullets are paired in the vertical column)

	YY		Blue		White		Red		Green		Yellow	
P. Black-P. Yellow	+ +		+ +		+	+		+ +	+	+	+	+
P. Red-P. Green	+ +		+	+	+	+	+	+	+	+	+	+
P. Black-P. White	+ +		+ +		+ +		+	+	+	+	+	+
P Green-P. Yellow	+	+	+	+	+	+	+	+	+	+	+	+
P. Black-P Red		+ +	+	+	+ +		+	+		+ +	+	+
P White-P Yellow	+ +		+	+	+	+	+	+	+	+	+	+
P Black-P Green	+ +		+	+	+	+		+ +	+	+	+	+
P Red-P. White	+	+	+	+	+	+	+	+	+	+	+	+
P. Green-P. White	+ +		+	+		+ +	+	+	+	+	+	+
P. Red-P. Yellow	+ +		+	+	+	+	+	+	+	+	+	+

TABLE 7

SOCIAL DISCRIMINATION OF PULLETS BY ROOSTERS IN GROUP D TABULATED + OR — AS THE ROOSTER CHOSE THE PULLET HIGHER OR LOWER IN NUMBER OF TIMES TREADED BY ROOSTERS UNDER EXPERIMENTAL CONDITIONS

	+	—
YY	8	10
Blue	11	7
White	11	7
Red	7	11
Green	8	10
Yellow	9	9
Totals	54	54

Tables 12-13 exhibit similar discriminations of pullets for mixed pairs. Table 14 exhibits an analysis based upon those mixed pairs alone that contain the three roosters that engage in Social Reflex No. 3.

TABLE 8

SOCIAL DISCRIMINATION OF PULLETS BY PULLETS IN GROUP D DURING THE TWENTY-EIGHTH TO THIRTIETH WEEKS EACH PAIR IS REVERSED FOR A SECOND DISCRIMINATION

(The pullets are paired in the vertical column)

	P. Black		P Yellow		P. White		P. Green		P. Red	
P Black-P Yellow					+ +		+	+	+	+
P Red-P Green	+	+	+ +		+	+				
P Black-P. White			+	+			+	+	+ +	
P Green-P. Yellow	+	+			+	+			+	+
P Black-P Red			+	+	+	+	+	+		
P White-P. Yellow	+	+					+	+	+ +	
P. Black-P. Green			+	+	+	+				+ +
P. Red-P. White	+	+	+	+			+	+		
P. Green-P White	+	+	+ +						+	+
P Red-P Yellow		+ +			+ +		+	+		

TABLE 9

SOCIAL DISCRIMINATION OF PULLETS BY PULLETS IN GROUP D TABULATED + OR — AS THE PULLET CHOSE THE PULLET HIGHER OR LOWER IN NUMBER OF TIMES TREADED BY ROOSTERS UNDER EXPERIMENTAL CONDITIONS

	+	—
P. Black	6	4
P Red	4	6
P Yellow	4	6
P Green	6	6
P. White	6	6
Totals	26	28

Tables 15-16 are reprinted from the second paper in this series, because the data also belong to this paper These tables exhibit the social discrimination of roosters by pullets in the Social Discrimination Cage at the 20th and the 28th weeks.

Because it is absolutely necessary for frequent reference in reading

TABLE 10

SEX DISCRIMINATION OF MIXED PAIRS BY ROOSTERS IN GROUP D DURING THE TWENTY-EIGHTH WEEK. EACH PAIR IS REVERSED FOR A SECOND DISCRIMINATION

(The pairing is in the vertical column)

	Y.Y.	Blue	White	Red	Green	Yellow
YY-P. Black		+ +	+ +	+ +	+ +	+ +
Blue-P. Black	+ +		+ +	+ +	+ +	+ +
White-P. Black	+ +	+ +		+ +	+ +	+ +
Red-P. Black	+ +	+ +	+ +		+ +	+ +
Green-P. Black	+ +	+ +	+ +	+ +		+ +
Yellow-P. Black	+ +	+ +	+ +	+ +	+ +	
YY-P White		+ +	+ +	+ +	+ +	+ +
Blue-P White	+ +		+ +	+ +	+ +	+ +
White-P. White	+ +	+ +		+ +	+ +	+ +
Red-P. White	+ +	+ +	+ +		+ +	+ +
Green-P. White	+ +	+ +	+ +	+ +		+ +
Yellow-P White	+ +	+ +	+ +	+ +	+ +	
YY-P. Red		+ +	+ +	+ +	+ +	+ +
Blue-P Red	+ +		+ +	+ +	+ +	+ +
White-P Red	+ +	+ +		+ +	+ +	+ +
Red-P Red	+ +	+ +	+ +		+ +	+ +
Green-P. Red	+ +	+ +	+ +	+ +		+ +
Yellow-P Red	+ +	+ +	+ +	+ +	+ +	
YY-P. Green		+ +	+ +	+ +	+ +	+ +
Blue-P Green	+ +		+ +	+ +	+ +	+ +

TABLE 10 (*Continued*)

	Y.Y.	Blue	White	Red	Green	Yellow
White-P. Green	+ +	+ +		+ +	+ +	+ +
Red-P. Green	+ +	+ +	+ +		+ +	+ +
Green-P. Green	+ +	+ +	+ +	+ +		+ +
Yellow-P Green	+ +	+ +	+ +	+ +	+ +	
YY-P Yellow		+ +	+ +	+ +	+ +	+ +
Blue-P. Yellow	+ +		+ +	+ +	+ +	+ +
White-P Yellow	+ +	+ +		+ +	+ +	+ +
Red-P. Yellow	+ +	+ +	+ +		+ +	+ +
Green-P. Yellow	+ +	+ +	+ +	+ +		+ +
Yellow-P. Yellow	+ +	+ +	+ +	+ +	+ +	

TABLE 11

SEX DISCRIMINATION OF MIXED PAIRS BY ROOSTERS OF GROUP D IN THE SOCIAL DISCRIMINATION CAGE DURING THE TWENTY-EIGHTH WEEK

	Male	Female
YY	0	50
Blue	0	50
Green	18	32
Yellow	25	25
Red	24	26
White	0	50
Totals	67	233

this paper, the charts that indicate the order of dominance in the male hierarchy of Group D are republished in Figures 6-9. It will be noticed that these charts are now complete to the 48th week, and that no change has taken place since the 36th week.

TABLE 12

SEX DISCRIMINATION OF MIXED PAIRS BY PULLETS IN GROUP D DURING THE TWENTY-EIGHTH WEEK. EACH PAIR IS REVERSED FOR A SECOND DISCRIMINATION

(The pairing is in the vertical column)

	P. Black		P. White		P. Red		P Green		P. Yellow	
YY-P. Black				+ +	+	+	+ +		+ +	
Blue-P. Black			+	+		+ +	+	+		+ +
White-P. Black			+ +			+ +	+ +			+ +
Red-P. Black				+ +		+ +	+	+		+ +
Green-P. Black			+ +			+ +	+	+		+ +
Yellow-P Black				+ +		+ +	+	+	+ +	
YY-P. White		+ +			+	+	+ +		+	+
Blue-P. White	+	+			+	+	+ +		+	+
White-P White	+	+			+	+		+ +	+	+
Red-P White	+	+			+ +		+	+	+	+
Green-P White	+ +				+	+	+	+	+ +	
Yellow-P White		+ +			+ +		+	+	+ +	
YY-P Red	+	+	+ +				+	+		+ +
Blue-P. Red	+ +		+ +				+	+	+	+
White-P Red	+ +		+ +				+ +		+ +	
Red-P Red		+ +		+ +			+	+	+ +	
Green-P Red	+ +		+	+			+	+	+ +	
Yellow-P Red	+ +		+	+			+	+	+	+
YY-P Green	+ +		+	+	+ +				+ +	
Blue-P. Green	+ +		+	+	+	+			+ +	

TABLE 12 (*Continued*)

	P Black		P White		P Red		P Green		P. Yellow	
White-P. Green	+ +		+	+	+	+			+ +	
Red-P. Green	+ +		+	+	+	+				+ +
Green-P. Green	+	+	+	+	+	+			+	+
Yellow-P. Green	+	+	+	+	+	+			+ +	
YY-P.-Yellow	+ +		+ +		+ +		+ +			
Blue-P. Yellow	+	+	+ +		+	+	+	+		
White-P. Yellow	+	+	+ +		+	+	+	+		
Red-P Yellow	+	+	+	+	+	+	+	+		
Green-P. Yellow	+	+	+	+	+	+	+	+		
Yellow-P Yellow		+ +	+	+	+	+	+	+		

TABLE 13

SEX DISCRIMINATION OF MIXED PAIRS IN THE SOCIAL DISCRIMINATION CAGE DURING THE 28TH WEEK FEMALE *Gallus domesticus*, GROUP D

	Male	Female
P. Black	30	18
P Yellow	29	19
P. White	28	20
P Red	23	25
P Green	29	19
Totals	139	101

TABLE 14

SEX DISCRIMINATION OF MIXED PAIRS BY PULLETS IN GROUP D DURING THE 28TH WEEK IN THIS TABLE ARE GIVEN ONLY THE TOTAL DISCRIMINATIONS OF THOSE PAIRS CONTAINING YY, BLUE, OR WHITE

	Male	Female
P Black	17	7
P. Yellow	14	10
P White	18	6
P Green	17	7
P Red	12	12
Totals	78	42

TABLE 15

SOCIAL DISCRIMINATION OF ROOSTERS BY PULLETS IN GROUP D DURING THE TWENTY-EIGHTH WEEK. EACH PAIR IS REVERSED FOR A SECOND DISCRIMINATION

(The pairings are in the vertical column)

	P. Black		P. Red		P Yellow		P Green		P. White	
YY-Blue	+	+	+ +		+ +			+ +		+ +
Red-Green	+	+	+	+		+ +	+	+	+	+
YY-White		+ +	+ +		+	+	+	+	+	+
Blue-Yellow	+ +		+	+	+ +		+	+	+	+
White-Red	+ +		+	+	+	+	+	+		+ +
YY-Red	+ +		+	+		+ +	+ +		+ +	
Blue-Green	+ +			+ +	+ +		+ +		+ +	
White-Yellow	+ +		+	+	+	+	+	+	+	+
YY-Green	+	+	+ +		+ +		+ +		+	+
Red-Yellow	+ +		+	+	+	+	+ +			+ +
Blue-White	+	+	+ +		+ +			+ +	+	+
YY-Yellow	+ +		+	+	+ +		+	+	+ +	
White-Green	+	+	+ +		+ +			+ +	+ +	
Green-Yellow	+	+	+ +			+ +	+	+	+	+
Blue-Red	+ +		+ +		+ +		+	+		+ +

ANALYSES OF THE DATA

Social Reflex No. 3 is the sex reflex and enters these experiments as a behavior quantum measurable in time and space units

1. *Measurement of Social Reflex No. 3.* This reflex is measured simply in terms of the number of treadings engaged in by each individual. These data are tabulated in Table 2 and show a wide

TABLE 16

SOCIAL DISCRIMINATION OF ROOSTERS BY PULLETS IN GROUP D DURING THE TWENTIETH WEEK. EACH PAIR IS REVERSED FOR A SECOND DISCRIMINATION

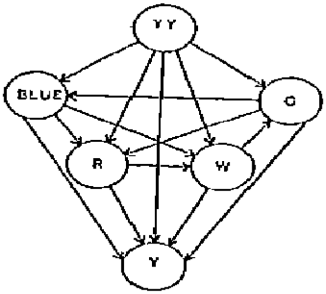
(The roosters are paired in the vertical column)

	P Black		P Red		P Yellow		P Green		P White	
YY-Blue	++		++		+	+		++	+	+
Red-Green	++		+	+		++		++		++
YY-White		++		++	+	+	+	+	++	
Blue-Yellow	+	+	+	+	++		++		+	+
White-Red	++			++	+	+	++			++
YY-Red	++		+	+	++		++		++	
Blue-Green	++			++	++		++		+	+
White-Yellow	++		+	+	++		++		+	+
YY-Green	++		++		++		++		++	
Red-Yellow	+	+		++	++		++		+	+
Blue-White		++	+	+	+	+	++		+	+
YY-Yellow	++		++		++		++		++	
White-Green	++			++	++		++		+	+
Green-Yellow	++			++	++		++		+	+
Blue-Red	++			++	+	+	+	+	+	+

range of individual differences. In the case of the pullets the range from 26 to 106 is quite impressive. In the case of the roosters the range from 0 to 140 is rather amazing. Certainly we have here an opportunity for covariable analyses.

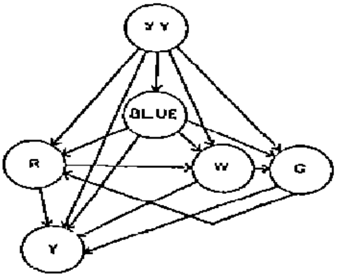
2. *Relation of Social Reflex No. 3 to Other Quanta of Behavior.*

a. The reflex as measured in pullets. Figure 10 indicates that there is a high linear relationship exhibited when Social Reflex No.



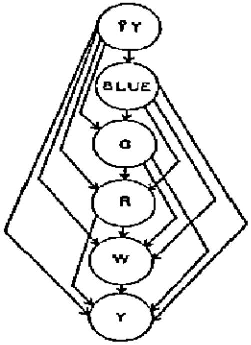
MALE "DOMINANCE" HIERARCHY
16TH WEEK

FIGURE 6



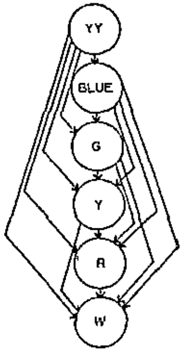
MALE "DOMINANCE" HIERARCHY
20TH WEEK
24TH WEEK
28TH WEEK

FIGURE 7



MALE "DOMINANCE" HIERARCHY
32ND WEEK

FIGURE 8



'MALE DOMINANCE" HIERARCHY
36 TH WEEK
40 TH WEEK
44 TH WEEK
48 TH WEEK

FIGURE 9

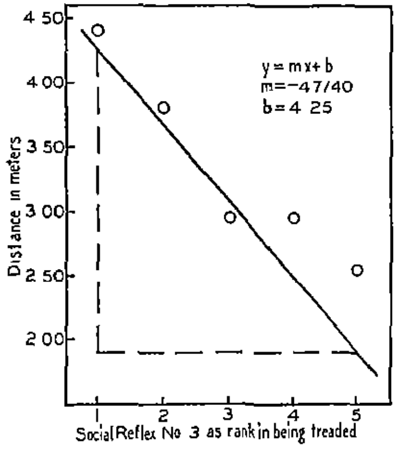


FIGURE 10

DISTANCE IN METERS OF SOCIAL REFLEX NO 1 TOWARDS EACH OTHER DURING THE 32ND WEEK AS A FUNCTION OF EFFICIENCY IN BEING TREADED BY ROOSTERS DURING THE PERIOD FROM THE 20TH TO THE 48TH WEEKS FEMALE *Gallus domesticus,* GROUP D

1 in meters is plotted as a function of Social Reflex No. 3 measured in terms of ranks in being treaded. This indicates that we are using a proper method for the measurement of Social Reflex No. 3. It is

a simple matter to measure Social Reflex No 1, while the direct measurement of Social Reflex No. 3 requires a long period of laborious observation If we are correct in our interpretation, it is possible to dispense with these laborious observations and measure Social Reflex No. 3 in pullets inferentially in terms of Social Reflex No 1.

b. The reflex as measured in roosters. In Figure 11 Social Reflex No 3 in seconds is plotted as a function of the positive units of Social Reflex No. 2. The time is determined in the Social Reflex Runway and is the time from release as if Social Reflex No 1 were being measured. In nearly every case where a mixed pair is released in the Social Reflex Runway, Social Reflex No. 1 terminates in Social Reflex No 3.

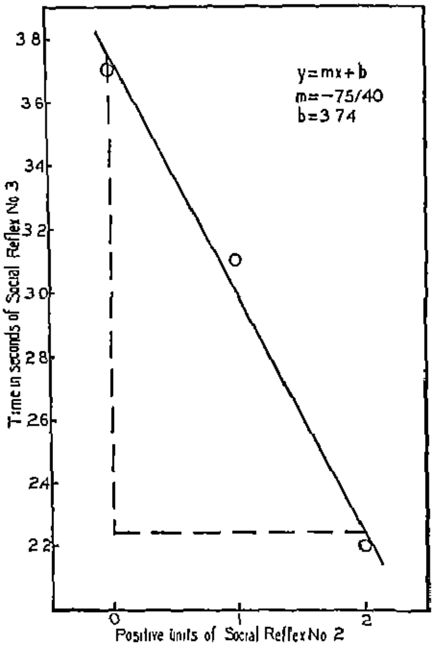


FIGURE 11

Time in Seconds of Social Reflex No. 3 as an Inverse Function of Social Reflex No 2 during the 32nd Week. Male *Gallus domesticus*, Group D

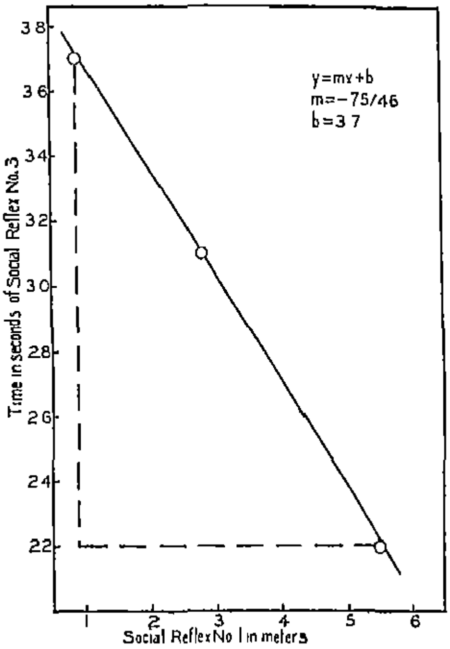


FIGURE 12

TIME IN SECONDS OF SOCIAL REFLEX NO 3 AS A LINEAR FUNCTION OF SOCIAL REFLEX NO. 1 IN METERS AT THE 32ND WEEK MALE *Gallus domesticus*, GROUP D

Figure 12 exhibits a perfect linear relationship when Social Reflex No. 3 in seconds is plotted as a function of Social Reflex No. 1 in meters This is one more indication that the measurement in terms of space of Social Reflex No. 1 is probably the simplest and most fundamental of all measurements of social behavior

Figure 13 indicates a high degree of linearity when Social Reflex No. 3 as measured by number of treadings is plotted as a function of the positive units of Social Reflex No 2 Perhaps by this time it is already anticipated that this relationship will be still more linear when Social Reflex No. 3 in number of treadings is plotted as a function of Social Reflex No 1 in meters, and this anticipation is realized in Figure 14.

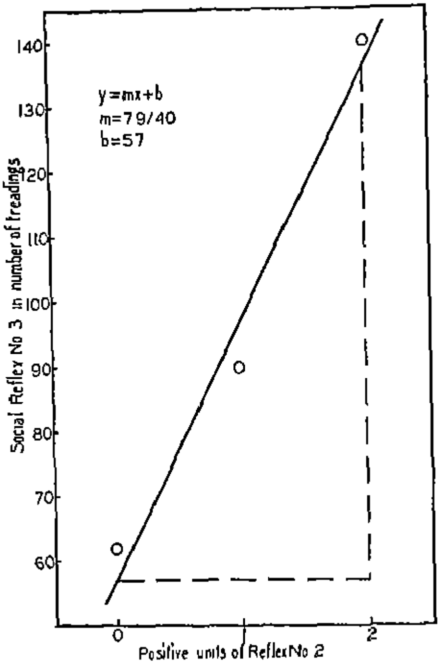


FIGURE 13

TREADING OF PULLETS THROUGHOUT THE PERIOD FROM THE 20TH TO THE 48TH WEEKS AS A FUNCTION OF SOCIAL REFLEX NO 2 IN MALES. *Gallus domesticus,* GROUP D

3. *A Theoretical Adjustment.* Suppose for a moment that all six of the roosters in this hierarchy were exhibiting Social Reflex No. 3, but that the total number of treadings were limited to the empirical data of this study. In such a case what might be the proper theoretical number of readings for each rooster? The answer is given in Figure 15. This figure is based entirely on the empirical data of this study and assumes only that the abscissa units are of equal size.

4 *Analyses Based on Social and Sex Discriminations.* Table 1 might indicate to some that the roosters prefer the lighter weight pullets. This is probably not the correct explanation and will be discussed later under unmeasured observations.

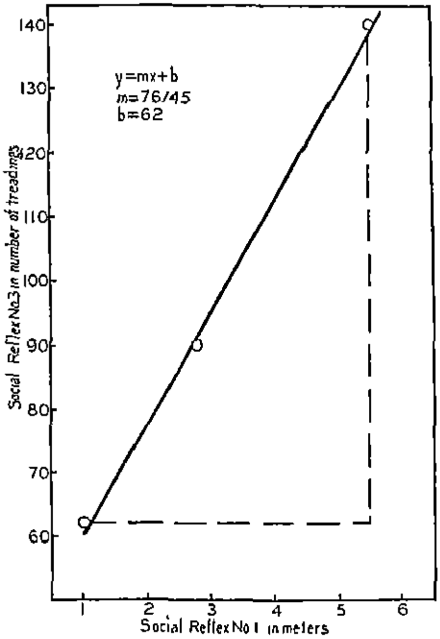


FIGURE 14

SOCIAL REFLEX No 3 IN NUMBER OF OBSERVED TREADINGS FROM THE 20TH TO THE 48TH WEEKS AS A FUNCTION OF SOCIAL REFLEX No 1 IN METERS AT THE 32ND WEEK MALE *Gallus domesticus*, GROUP D

A rooster that treads pullets responds much more rapidly to a pullet in the Social Reflex Runway than he does to another rooster. The average differences for a series of observations are exhibited in Table 3.

Tables 6-7 would seem to indicate that these roosters, with the exception of *YY*, do not have a keen discrimination for individual differences in pullets. How can these facts be reconciled with the facts of Table 2? Only an impressionistic answer is possible, and this will be given later under unmeasured observations.

Tables 8-9 indicate with equal clearness that the pullets do not discriminate sex-rank differences among themselves. The probable explanation will be given later.

Tables 10-11 are very remarkable In the Social Discrimination

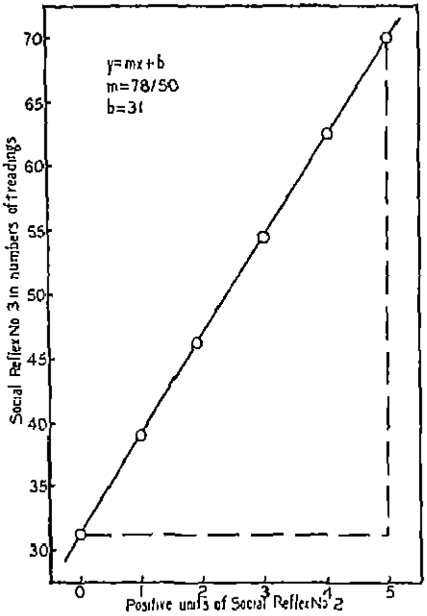


FIGURE 15

A Theoretical Curve to Show the Number of Treadings Each Rooster Might be Expected to Get if All Six Roosters Engaged in This Reflex and if the Total Number of Treadings Were Limited to the Empirical Data of This Study

Cage a rooster that treads pullets will always respond to the female member of a mixed pair, while roosters that do not tread pullets will make discriminations that approximate their relative rankings in the hierarchy. It would be interesting to play with the idea of measuring limens for Social Reflex No. 3, and measuring those limens in terms of discrimination percentages.

The above discrimination differences are not so remarkable in the case of pullets. Regardless of rank in being treaded there is a preference for the male, but the degree of the preference is about the same in all the pullets except *P. Red* which seems to exhibit chance discrimination. If Table 14 is compared with Tables 12-13, it will be seen that the positive sex discriminations are greatly in-

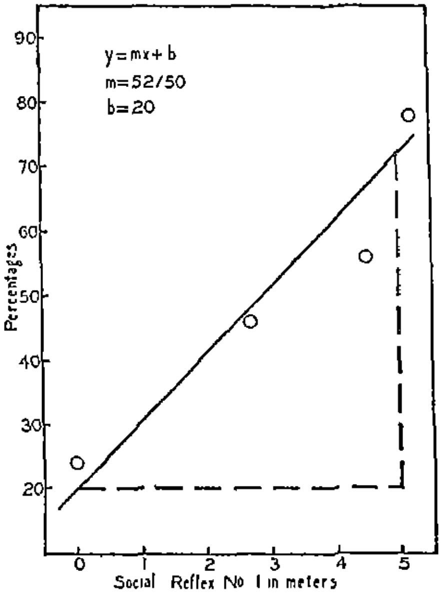


FIGURE 16
PERCENTAGES OF TIMES A MALE RECEIVES POSITIVE SOCIAL DISCRIMINATIONS FROM A PULLET PLOTTED AS A FUNCTION OF SOCIAL REFLEX NO 1 OF THE MALE DURING THE 20TH WEEK MALE *Gallus domesticus*, GROUP D

creased if only the roosters that tread pullets are used in the mixed pairs

Figures 16-19 are reprinted here from the second paper in this series in order to demonstrate that the social discriminations of roosters by pullets are at least crudely differentiated, but are far from being so keen as are the social discriminations of roosters by roosters. This seems to be a fundamental sex difference in *Gallus domesticus*.

SOME UNMEASURED OBSERVATIONS

1 *The Mechanics of the Sex Reflex* A rooster, coming into close proximity with any pullet, will mince around her with short quick steps, one wing drooping, and with characteristic guttural

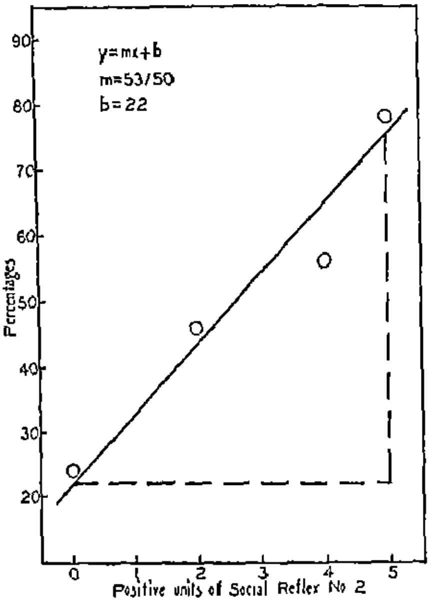


FIGURE 17
PERCENTAGES OF TIMES A MALE RECEIVES POSITIVE SOCIAL DISCRIMINATIONS FROM A PULLET PLOTTED AS A FUNCTION OF SOCIAL REFLEX NO. 2 OF THE MALE DURING THE 20TH WEEK. MALE *Gallus domesticus*, GROUP D

sounds. If the pullet is stationary, she will be shoved gently from her stationary position. If the pullet remains standing bolt upright, the performance may be repeated. If the pullet darts away, attention is usually transferred to the next nearest pullet. This may be classified as the rooster's sex invitation, and it is freely extended to any pullet at any time. If the pullet responds to the sex invitation by making a very slight curtsy, a treading rooster that has not very recently treaded some other pullet will immediately tread her. A rooster that does not tread pullets makes no characteristic response to this curtsy. A rooster that has very recently treaded some other pullet will respond to the curtsy by a few moments of hesitation before walking away.

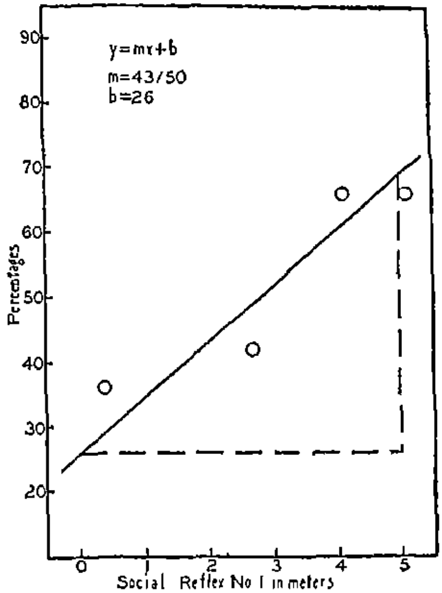


FIGURE 18

PERCENTAGES OF TIMES A MALE RECEIVES POSITIVE SOCIAL DISCRIMINATIONS FROM A PULLET PLOTTED AS A FUNCTION OF SOCIAL REFLEX No 1 OF THE MALE DURING THE 28TH WEEK MALE *Gallus domesticus*, GROUP D

2 *The Mechanics of the Social Insult.* A rooster, coming into close proximity with any subordinate rooster, will greet him with the characteristic behavior of the sex invitation The subordinate rooster accepts the insult and walks away If any rooster greets a superior rooster in this manner, the insult is resented and a fight begins immediately This behavior may be classified as the characteristic social insult of rooster society, and is something that is freely extended at all times by all superior roosters to all subordinate roosters

3 *The Mechanics of the Favorite Pullet.* The favorite pullet becomes so through simple mathematics. She is the one that responds most quickly to the voices or to the visible presence of the others, and consequently is the pullet that a rooster most frequently meets with

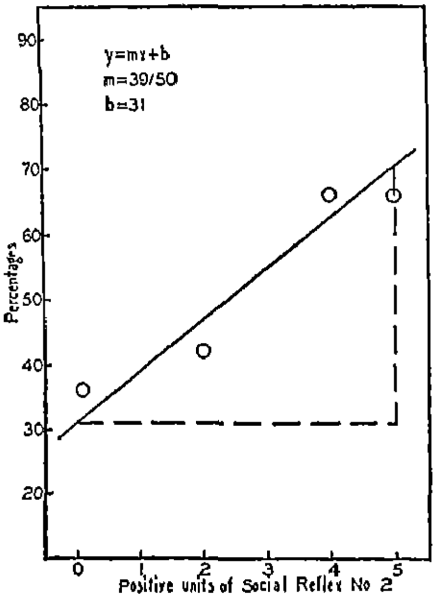


FIGURE 19

PERCENTAGES OF TIMES A MALE RECEIVES POSITIVE SOCIAL DISCRIMINATIONS FROM A PULLET PLOTTED AS A FUNCTION OF SOCIAL REFLEX NO 2 OF THE MALE DURING THE 28TH WEEK. MALE *Gallus domesticus*, GROUP D

first She also is the one that is most free with her curtsies. The greater total of treadings which she receives is therefore a matter of simple arithmetic and not an indication of preference on the part of the roosters. The favorite pullet is halted in her addition by the development of a phenomenon known as a sore back As her back becomes more tender because of the rough treatment accorded her by the toenails of the roosters, she refuses to be treaded by roosters This allows the other pullets to get caught up in their totals.

4 *The Mechanics of Social Integration.* The most dominant rooster works smoothly and gently. He seldom shows irritation towards his fellows and does his pecking as if it were play He may be handled easily by the experimenter, and never resists, runs away,

or struggles. He will stand quietly wherever he may be placed by the experimenter, and gives one the impression that he is adequate for any rooster situation that may arise The least dominant rooster seems to be under a strain at all times He is difficult to handle. He runs away, resists, and struggles violently He is irritated at all times and never remains where he is placed. He is never adjusted to any situation, and continually fills the experimenter's mind with thoughts of murder The other four roosters in the group of six are arranged fairly evenly between these two extremes. The pullets are dominated by all the roosters, but do not exhibit any of the symptoms of strain and maladjustment that are so typical of the rooster at the bottom of the hierarchy. When a rooster is pecked by a superior he runs away quietly, head down, with an air of dejection When a pullet is pecked by a rooster, she usually darts away with spirit, head up, and with a startled cackle.

GENERAL SUMMARY

Social Reflex No. 3 is measured in terms of the total treadings in which each individual engages during a period of time. As so measured this reflex in male *Gallus domesticus* is a linear function of Social Reflex No. 1 and Social Reflex No. 2, while in female *Gallus domesticus* it is a function of Social Reflex No. 1. Observations seem to indicate that such subjective matters as sex favoritism, social insults, and social integration may eventually be exhibited as linear functions of such measurable quanta as Social Reflex No. 1, Social Reflex No. 2, and Social Reflex No 3.

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2. ——— The experimental measurement of a social hierarchy in *Gallus domesticus*. II The identification and inferential measurement of Social Reflex No 1 and Social Reflex No 2 by means of social discrimination. *J Soc Psychol.*, 1935, **6**, 3-30

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LA MESURE EXPÉRIMENTALE D'UNE HIÉRARCHIE SOCIALE III. LA MESURE DIRECTE ET PAR VOIE DE DÉDUCTION DU RÉFLEXE SOCIAL NO. 3

(Résumé)

On mesure le Réflexe Social No. 3 en termes du piétinements totaux faits par chaque individu pendant une période de temps Comme on le mesure ainsi, ce *réflexe* chez *Gallus domesticus* mâle est une fonction linéaire du Réflexe Social No 1 et du Réflexe Social No. 2, tandis que chez *Gallus domesticus* femelle c'est une fonction du Réflexe Social No 1. Les observations semblent indiquer que les choses subjectives telles que le favoritisme sexuel, les insultes sociales, et l'intégration sociale peuvent être montrées à la fin comme des fonctions linéaires des quanta mesurables tels que le Réflexe Social No 1, le Réflexe Social No 2, et le Réflexe Social No 3

MURCHISON

DIE EXPERIMENTELLE MESSUNG EINER SOZIALEN HIERARCHIE· III DIE UNMITTELBARE UND FOLGERUNGSMESSUNG DES SOZIALEN REFLEXES NR 3

(Referat)

Der soziale Reflex Nr 3 wurde in bezug auf die Gesamschritte gemessen, die jedes Einzelwesen wahrend eines Zeitraumes macht Wenn er auf diese Weise gemessen wird, ist dieser Reflex bei dem mannlichen *Gallus domesticus* eine Linearfunktion des sozialen Reflexes Nr. 1 und des sozialen Reflexes Nr. 2, wahrend bei dem weiblichen *Gallus domesticus* ist er eine Funktion des sozialen Reflexes Nr 1. Die Beobachtungen weisen darauf hin, dass solche subjektiven Sachen, wie Geschlechtsbegunstigung, soziale Beschimpfung, und soziale Integration schliesslich als Linearfunktionen solcher messbaren Quanta wie des sozialen Reflexes Nr. 1, des sozialen Reflexes Nr 2, und des sozialen Reflexes Nr 3 dargestellt werden konnen.

MURCHISON

IMITATIVE BEHAVIOR IN THE RHESUS MONKEY[1]

From the Laboratory of Comparative Psychology, Columbia University

C J Warden and T. A. Jackson[2]

Many of the pioneer writers in the field of comparative psychology were greatly interested in the problem of the distribution of "rational" imitation in animals. This type of activity was distinguished from "instinctive" imitation by the fact that it involved the sudden emergence of new response patterns rather than the mere appearance of simple instinctive patterns The term "rational" was applied because it was believed that the sudden imitation of an act, after observing it in another animal, is dependent upon an inferential process of some sort The imitator presumably reasons, for example, that since pulling a string brings food to the imitatee it will also bring food to himself Such an interpretation of an act of imitation is obviously anthropomorphic. Most present-day comparative psychologists prefer to regard imitation as merely learning by observation. Whether the process is rational or not is often difficult to determine in either animal or human subjects. In any case, learning by observation is a relatively high-level activity as compared with the usual slow and laborious trial-and-error learning. One should expect to find this capacity only in highly complex organisms which have the ability to observe with some care the movements of their fellows.

As pointed out by Warden (16), intelligent imitation must meet the following criteria. (*a*) the task must be novel and sufficiently complex, (*b*) the response must appear immediately after observing the imitatee, (*c*) practice must be excluded by the experimental conditions, (*d*) the act of the imitator must be substantially identical with that of the imitatee, and (*e*) a sufficient number of instances must occur, under varied conditions, to eliminate the chance factor.

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[1] This report covers one major topic in the project on Motivation and Intelligence in the Rhesus Monkey (under the direction of Professor C J. Warden), supported by the Council for Research in the Social Sciences of Columbia University

[2] The general method employed was devised by the senior author and the specific tasks and procedure developed in collaboration The junior author carried out the tests and tabulated the data and the senior author wrote the final report

This set of criteria has seldom if ever been strictly adhered to in actual experimental work In some cases the tasks set have been so simple for the animal as to be practically on the instinctive level. Watson (18) has suggested, in this connection, that the task should not be too novel or complex in fairness to the animal. It is enough, perhaps, that the task involve merely a new pattern of previously learned unit activities Haggerty (6) and others permitted considerable practice at the task (with continued failure) before giving the imitation tests. The requirement that the response follow the observation immediately has been generally disregarded. Moreover, numerous acts have been classed as imitative when they were quite unlike those of the imitatee, sometimes involving the use of an entirely different appendage. In most instances the number of cases of positive imitation reported in a given experiment has been too few to eliminate entirely the chance factor.

In spite of the lack of rigorous application of these criteria the results on tests for birds and mammals have been mainly negative. Thorndike (15) found no evidence for imitation in chicks, and the results of Porter (11) on various species of birds are inconclusive. Small (13, 14) decides against imitation in the white rat, whereas Berry (1) argues for a low order of imitation in this type. The negative results of Thorndike (15) on the cat and dog are well known Berry (1) and Hobhouse (8) insist that cats possess a low order of imitativeness. The tests of Cole (3) and Davis (4) on the raccoon were disappointing. In general, the opinion has steadily gained ground that genuine imitation does not occur among the subprimate forms

The results to date on monkeys and apes are more or less inconsistent and confusing Thorndike (15) found little or no evidence for intelligent imitation in monkeys. The instances cited by Hobhouse (8) are not very convincing. Shepherd (12) concludes that imitation, when present at all, is of little importance in the learning of monkeys The results of Watson (17) were negative, regardless of whether the imitatee were another monkey or himself. Kinnaman (9) reports two cases of imitation in the rhesus monkey, but these followed a considerable amount of practice on the task Haggerty (6, 7) offers the best evidence to date for imitation in monkeys Instances of clear-cut imitation were limited to a few of the animals tested, and some of the tasks involved were exceedingly simple for primates He reports numerous cases of "partial" imitation in which observation apparently aided the imitator in solving the problem by trial-and-error activities. As a rule, however, the monkeys were allowed practice at the task before being tested for imitation.

Several workers have noted instances of social facilitation and simple imitative behavior in the great apes. Nevertheless, both Yerkes (19) and Kohler (10) seem to feel that there is little reason to suspect a high order of imitativeness even in the chimpanzee.

As pointed out by Warden (16), most workers have made use of one or another of two methods for testing imitation: (*a*) the Kline Single-Cage method, or (*b*) the Thorndike Observation-Cage method. The first method was devised by Kline in testing the white rat, was later extended by Hobhouse to various mammals, and by Porter to birds. The imitator is simply placed in the problem cage along with the previously trained imitatee. He may merely observe the imitatee, or go further and attack the puzzle device while the latter is in the act of operating it It is thus impossible to eliminate trial-and-error activities and secure mere observation. This method has been generally discarded for that devised by Thorndike in which the imitator is placed in an observation cage attached to the problem cage containing the imitatee. After the period of observation is over, the imitatee must be removed from the problem cage and the imitator transferred thereto This procedure involves a period of delay between observation and the imitative act and doubtless tends to disrupt the latter. It may be seriously questioned, therefore, whether the negative results so often secured by this method are to be accepted at their face value In any case, the method does not offer a natural situation for the appearance of imitative activities

Since the two methods used heretofore appeared to be unsatisfactory, the senior author set about to devise a new type of imitation test. The general plan of this test is embodied in the Warden Duplicate-Cage apparatus for monkeys which was constructed for the present project (page 103, footnote) in 1930 This method involves the presentation of a duplicate puzzle device to the imitator in the observation compartment. This makes it unnecessary to shift either of the animals about during a given work period. The imitator may react at once, upon observing the imitatee, since the puzzle device is ready at hand. Moreover, the imitative tendency when aroused is not disrupted by a shift of any sort. The Duplicate-Cage method would thus seem to provide the natural setting for the occurrence of imitative behavior in animals and children.

METHOD AND PROCEDURE

A diagram of the apparatus employed is shown in Figure 1. Each of the two compartments measured 36 inches long, 30 inches wide, and 36 inches high. The dividing screen was made of ½-inch wire mesh which permitted clear observation of the movements of the imitatee. It was found in preliminary tests that the monkey may be distracted by the presence of the experimenter in the room, hence the one-way light screen technique was employed. This involved

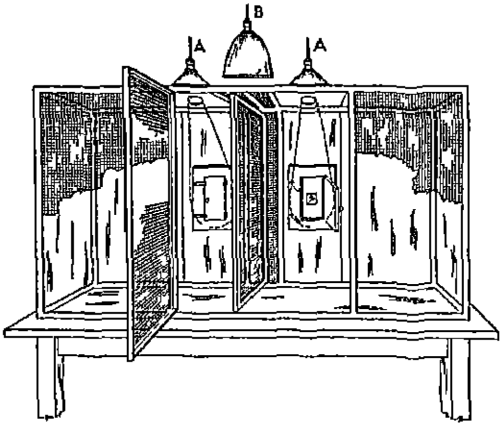

FIGURE 1

WARDEN DUPLICATE-CAGE IMITATION APPARATUS

A part of the mesh forming the front of the apparatus has been removed so as to make the interior of the cages more visible The cages for the imitatee and imitator are identical in every respect The double-latch device is shown open in one cage and closed in the other The two lights, *A*, *A*, supply general illumination and enhance the attention value of the puzzle devices. New devices can be substituted for those shown by changing panels. The two cages are separated by a wire-mesh partition.

(By courtesy of C. J Warden)

covering the top of the cage with heavy black cloth and the back and sides with beaver board. A screen of rayon cloth through which the experimenter could observe the animals was lowered in front of the cage before making each test. The inside of each compartment was illuminated by an automobile spotlight (32 candle power) trained directly upon the panel bearing the puzzle device In addition to supplying general illumination, these lights tended to enhance the stimulation value of the puzzle devices. The large central light was not used during the testing period and all lights in the room were turned off before beginning a test A large electric fan was operated at low speed to serve as a sound screen

The puzzle devices were mounted on removable panels as indicated in Figure 1 The panels were placed close to the division screen so as to favor ready observation In this position the imitator was enabled to secure a profile view of the imitatee during his attack upon the problem The following tasks, arranged in order of difficulty, were employed · (1) pulling a chain which hung down within easy reach in front of the panel, thus raising a door and exposing a raisin in a hole in the panel, (2) opening a door in the panel, behind which a raisin had been placed, by manipulating a knob, (3) operating a simple latch and then opening the door, and (4) operating two latches, arranged as in Figure 1, and then opening the door As will be seen, the last three problems represented a progressive series of acts The four problems were first learned by the imitatee and then presented to the several imitators in the order given above.

The question may arise as to whether or not these tasks are sufficiently difficult to require genuine learning in the case of the monkey. There would seem to be no reason to believe that these tasks lie within the unlearned repertory of the monkey The first two problems are relatively simple and conceivably might be learned within a short time by trial-and-error reactions. However, such behavior was reduced to a minimum, under our conditions, by allowing the imitator only 60 seconds in which to perform, after having observed the imitatee in a given test The fact that some failures occurred on these two tasks suggests that they lie somewhat above the "instinctive" level. Moreover, two prospective imitatees were finally discarded because they failed to learn to perform the several tasks consistently by trial-and-error after a considerable amount of training of the type indicated in the following paragraph. Since the first task was considered the simplest, a control test was run on 5 monkeys that were not to be used in the experiment proper. These animals were well tamed and similar in general to those employed later in the regular imitation tests. In no case did an animal learn to pull the chain and secure the food within six test periods of 60 seconds each, corresponding to the total performance time of the imitation tests In fact, one animal failed consistently through 30 test periods, although others showed a tendency to learn when the work period was thus extended. It is clear, therefore, that even this simple task was too difficult to be learned by trial and error within the total time (6 minutes) allowed the imitator in the experiment proper.

This conclusion is further strengthened by the fact that it required considerable time and effort to train the imitatee on the several tasks. As noted above, two prospects were discarded because they did not learn readily and consistently. The imitatee finally chosen was able to learn the 4 problems in two daily sessions of somewhat less than an hour each. Since the aim was to train the animal as quickly as possible, special conditions favorable to speedy learning were introduced. In the second problem, for example, the door to the hole in the panel was first left open, thus exposing the raisin. Later it was partly closed, and finally entirely closed and latched so that the animal had to turn the knob The third and fourth tasks were likewise simplified in order to hasten the process of training. Doubtless the training time would have been greatly increased if the imitatee had not been aided in this manner. As it was, the time required to learn the 4 tasks was several times as great as the total time allowed an animal on these four tasks in the imitation tests (24 minutes).

The general procedure was determined in various preliminary tests made on four rhesus monkeys similar in general to those that were used later in the experiment proper. It was found that imitator and imitatee were likely to come together on either side of the division screen and fight or play, unless restrained in some manner This tended to divert one or both of them from attacking the problem at hand. This difficulty was overcome by the use of a guide cord on each animal The cord was attached to the belt (worn continuously) which passed around the abdomen of the animal and then extended through the corner of the compartment in front. Thus both imitator and imitatee could be released at the proper moment and, by a slight pull of the cord, returned again to the starting position. The appropriate response seemed to be facilitated by the flashing on and off of the lights in the cage The two cords were operated from the experimenter's table and little difficulty was experienced in managing the animals by means of this simple technique.

The test procedure may be indicated very briefly The two animals, with cords attached, were placed in their respective compartments, and anchored in the proper position by the experimenter. The two puzzle devices were set and baited by a helper[3] stationed behind the apparatus. The room lights were then turned off. The panel of the imitatee was then illuminated by means of the spot light and the imitatee allowed to perform. The animal was drawn back to the corner of the cage, the light turned off, and the puzzle device re-set. This procedure was repeated five times in rapid succession, the five performances of the imitatee requiring only about 30 seconds Immediately after the fifth performance, the light was turned off in the imitatee's compartment and flashed on in the other compartment. The imitator was released and allowed 60 seconds in which to solve the problem as observed The imitator was usually leaning forward against the taut cord and often went directly to the panel. If the problem had not been solved within the 60-second period, the imitator was drawn back to the corner of his compartment. Only two tests were given per day, the second one coming 30 to 40 seconds after the first. The exact time required for each solution was taken with a stop watch.

Each animal was tested on a given problem on three successive days. This arrangement involved 30 possible observations together with 6 opportunities to imitate for each of the tasks After an interval of 4 days, an animal was transferred to the next problem of the series. The interval was made as long as was conveniently possible in order to reduce immediate transfer and interference effects. As will be seen, each animal was given 24 tests of imitation altogether. Since 15 monkeys were used in the experiment proper, a total of 360 tests of imitation are included in the study.

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[3] Thanks are due to H A Fjeld and J. P Foley, Jr, for valuable aid in this connection

A total of 21 monkeys was utilized in the study. Five of these were employed in such preliminary tests as were found necessary in standardizing the method, and then were shifted to some other experiment in the laboratory. A single male was used throughout as the imitatee so as to keep this factor of the social situation constant This animal weighed 149 ounces and was approximately 43 months of age. Although somewhat nervous in temperament, his performances were consistently definite and speedy. He was especially suitable for our purposes since he did not attempt to fight back when

TABLE 1

SHOWING CERTAIN CHARACTERISTICS OF THE MONKEYS USED AS IMITATORS
The first 8 animals (A to H) were males, the last 7 (R to X) were females

Monkey	Weight (oz)	Est. age (mos)	Behavioral characteristics
A	137	40	Showed pugnacious attitude toward imitatee, which disrupted imitative performance
B	148	40	Good subject, worked well
C	133	39	Excellent subject, imitated in perfect form.
D	146	45	Good subject through first three problems, then developed an interest in the imitatee.
E	138	44	Good subject; worked well.
F	135	40	Poor subject; very timid; became negative to the whole set-up Sex excitement marked.
G	124	36	Poor subject, very timid, masturbated frequently and "presented" to the imitatee. Played around and ignored problem
H	146	42	Good subject only in the first problem; then showed sex interest in imitatee, "presented" to him and ignored the problem; sat at screen near imitatee
R	107	34	Very good subject; worked well and promptly
S	151	46	Poor subject; animal showed much sex interest in imitatee. Sex organ swellings prominent, very emotional and hard to handle Sat at partition near imitatee and ignored problem
T	154	45	Poor subject, animal showed much interest in imitatee, sex organ swellings prominent Animal very emotional and hard to handle. Masturbated frequently and ignored problem
U	141	41	Very good subject
V	111	37	Poor subject, emotional and pugnacious toward imitatee and experimenter; never really adjusted to experimental situation
W	133	40	Very good subject, worked well.
X	112	42	Fair subject; slow and somewhat timid.

the other animals exhibited pugnacity from time to time. It might have been better to have trained a female to serve as imitatee for the females. This is suggestive by the fact that several of the older females tended to show more interest in this male than in the problem. This factor probably had the effect of reducing the score of imitative behavior in such cases below the potential level

A brief description of the 15 monkeys used as imitators in the experiment proper will be found in Table 1. As will be noted, the animals are grouped according to sex. The individuals differed considerably in age as estimated by weight and other criteria of development (5) All of the subjects (except H) had been worked for many months by Fjeld (5) before being used in the imitation experiment. This means that they were not only well tamed but also readily adjustable to a new experimental situation. Before being tested for imitation, each monkey was placed in the imitator's compartment for ten minutes on from 1 to 4 days During this period of adjustment, blank panels were substituted for those bearing puzzle devices and the imitatee was present in the opposite cage. No bait was provided during such preliminary periods The number of periods varied since some of the monkeys required a longer time in which to become adjusted than others Most of the animals readily adapted themselves to the changes in lighting and the pull of the guide cords, later associated with the testing routine In brief, every effort was made to eliminate emotional factors that might have an adverse influence upon a proper observational set

The care of the animals has already been described in detail by Fjeld (5) Each individual had been caged alone during the months that the animals were kept in the laboratory, so as to prevent the formation of social attachments that might prove troublesome The tests were conducted betwen 2.30 and 3:30 in the afternoon. The animals were reasonably hungry at this hour of the day since they were given no solid food until after the tests were completed. The morning meal consisted of milk enriched by raw eggs, and no other ration was supplied previous to testing The morning meal was served at 7 o'clock regularly The puzzle devices were baited with raisins because these were known to possess a high incentive value in the case of the rhesus monkey.

RESULTS

In considering the results secured it will be necessary to recognize the possibility of varying degrees of imitativeness. Haggerty (6) has called attention to the fact that monkeys may exhibit a tendency to imitate and still not be entirely successful in solving the problem at hand. After a careful analysis of the quality of social facilitation observed in our animals, it was decided to recognize the following types of imitative activity.

I, immediate imitation—solution of task within the 60-second test period.

P+, partial imitation—proper act occurred but not exact or forceful enough to work the mechanism.

P, partial imitation—contact made with proper part of mechanism but appropriate movement incomplete

P—, partial imitation—puzzle device approached and parts inspected but without body contact with it.

F, failure to imitate—no apparent attention to puzzle device; interest centered on imitatee as shown by sexual and pugnacious behavior

The individual records for the 6 tests on each of the 4 problems are presented in Tables 2, 3, 4, and 5. The record for a given

TABLE 2

SHOWING THE RECORD OF EACH MONKEY FOR THE SIX TESTS ON PROBLEM 1

Monkey	Test 1		Test 2		Test 3		Test 4		Test 5		Test 6	
	Sec	R	Sec.	R	Sec	R	Sec	R	Sec	R	Sec.	R
A	60	F	60	F	60	P	60	P+	49	I	60	P
B	60	P—	27	I	63	P+	5	I	20	I	21	I
C	30	I	50	P+	60	P—	14	I	59	I	21	I
E	60	I	60	P	60	P—	60	F	60	P—	60	F
F	60	P+	1	I	60	F	60	P—	60	P+	36	I
G	60	F	60	P+	60	P+	50	I	55	I	60	P+
H	58	I	52	I	2	I	20	I	7	I	10	I
R	60	P—	4	I	50	I	9	I	40	I	2	I
S	60	F	60	P—	60	F	60	P—	60	P—	60	F
T	60	P	60	P	60	P	60	I	60	P	60	P+
U	60	F	60	F	1	I	60	P—	60	P	60	P
V	60	F	60	P+	60	P+	8	I	60	P+	60	P
W	60	P—	60	P—	44	I	60	P—	11	I	23	I
X	55	I	60	F	60	P—	59	I	48	I	33	I

Through an oversight, D was not tested on this problem. For the meanings of the letter ratings (R) see this page.

TABLE 3

SHOWING THE RECORD OF EACH MONKEY FOR THE SIX TESTS ON PROBLEM II

Monkey	Test 1 Sec	 R	Test 2 Sec	 R	Test 3 Sec	 R	Test 4 Sec	 R	Test 5 Sec	 R	Test 6 Sec.	 R
A	15	I	21	I	11	I	2	I	3	I	3	I
B	60	P—	49	I	3	I	2	I	1	I	1	I
C	9	I	10	I	2	I	2	I	2	I	2	I
D	58	I	2	I	5	I	2	I	5	I	5	I
E	2	I	16	I	8	I	9	I	4	I	2	I
F	60	P—	60	P—	60	P—	60	P—	60	P—	60	P—
G	60	P—	60	F	60	F	60	F	60	F	60	F
H	60	F	60	F	60	F	60	F	60	F	60	F
R	53	I	10	I	1	I	3	I	7	I	15	I
S	60	F	60	F	60	F	60	F	60	P	60	F
T	60	F	60	F	60	P—	60	P—	60	P—	60	F
U	60	P—	33	I	10	I	2	I	1	I	3	I
V	60	P—	60	P—	60	F	60	F	60	F	60	F
X	60	P+	50	I	5	I	2	I	10	I	6	I

For the meaning of the letter ratings (R) see Page 112

TABLE 4

SHOWING THE RECORD OF EACH MONKEY FOR THE SIX TESTS ON PROBLEM III

Monkey	Test 1 Sec	 R	Test 2 Sec	 R	Test 3 Sec	 R	Test 4 Sec	 R	Test 5 Sec	 R	Test 6 Sec	 R
A	6	I	60	P+	60	P+	60	P+	60	P—	59	I
B	39	I	60	P+	60	P+	60	P	38	I	60	P+
C	60	P—	60	P—	60	P—	60	P—	52	I	57	I
D	3	I	40	I	17	I	13	I	8	I	12	I
E	59	I	60	P—	60	P	55	I	36	I	24	I
F	60	F	60	F	60	P—	60	F	60	P—	60	F
G	60	P—	60	P—	60	F	60	F	60	F	60	F
H	60	F	60	F	60	F	60	F	60	F	60	F
R	8	I	6	I	54	I	39	I	12	I	15	I
S	60	P—	60	P	60	F	60	F	60	F	60	F
T	60	F	60	F	60	F	60	F	60	P	60	F
U	1	I	8	I	10	I	8	I	3	I	6	I
V	60	F	60	F	60	P—	60	F	60	P—	60	F
W	18	I	3	I	51	I	18	I	8	I	22	I
X	10	I	6	I	60	P+	42	I	60	F	60	F

For the meaning of the letter ratings (R) see Page 112

performance includes a time score and a rating as to the degree of imitativeness exhibited The ratings are assigned in accordance with the letter system indicated above, and range in grade from immediate imitation to outright failure In the case of failures the time score is

TABLE 5

SHOWING THE RECORD OF EACH MONKEY FOR THE SIX TESTS ON PROBLEM IV

Monkey	Test 1		Test 2		Test 3		Test 4		Test 5		Test 6	
	Sec.	R	Sec	R	Sec.	R	Sec.	R	Sec.	R	Sec	R
A	55	I	55	I	23	I	18	I	5	I	11	I
B	45	I	8	I	17	I	11	I	5	I	2	I
C	40	I	15	I	21	I	9	I	21	I	7	I
D	60	P	60	P	60	P+	60	P	60	P—	60	P—
E	13	I	4	I	16	I	44	I	39	I	21	I
F	60	F	60	P	60	P—	60	F	60	P—	60	F
G	60	F	60	F	60	P—	60	P—	60	P—	60	F
H	60	F	60	F	60	P—	60	F	60	F	60	F
R	18	I	56	I	4	I	9	I	10	I	8	I
S	60	F	60	F	60	F	60	F	60	F	60	F
T	60	F	60	P	60	P	60	P—	60	P—	60	P—
U	8	I	6	I	8	I	7	I	60	P+	28	I
V	60	F	60	F	60	P—	60	P—	60	P—	60	F
W	24	I	12	I	18	I	30	I	9	I	6	I
X	60	P—	60	P—	60	P—	34	I	17	F	25	I

For the meaning of the letter ratings (R) see Page 112

always 60 seconds since this was the total time allotted to a given test. The time scores vary considerably when imitation (immediate or partial) occurred, depending on precisely when the appropriate act took place As will be noted, numerous instances of immediate imitation required only a few seconds after the end of the observational period. Obviously, the shorter the time the less the opportunity for trial-and-error reactions to play a part in solving the problem An analysis of the results with reference to the speed or readiness of the imitative response will be made in a later connection

As might be expected, the amount of imitative behavior varied considerably from task to task. The 84 tests on problem I yielded 35 cases of immediate imitation, 36 cases of partial imitation, and 13 cases of complete failure. The 90 tests on problem II yielded 48 cases of immediate imitation, 18 cases of partial imitation, and 24 cases of failure The corresponding scores for problem III were 37, 24, and 29, and for problem IV, 44, 25, and 21. It thus appears that some degree of social facilitation was the rule rather than the exception, as has usually been found.

In the above computations the 3 types of partial imitation were pooled for the sake of brevity. As a matter of fact, the P+ type of activity is highly imitative although not resulting in a solution of the problem. The proper form of the movement was copied but not with enough exactitude or force to operate the essential mechanism. There were 12 cases of this type on the first problem, 1 case on the second problem, 7 cases on the third problem, and 2 cases on the fourth problem. The P— type doubtless involves little more than an enhancement of the stimulus arising from the general social setting, and is fairly close to the failure level. The number of cases of this type of activity for the four problems runs as follows: 14, 16, 13, 17. But even if these values be added to the outright failure scores the total is only 147 or 41.5 per cent of the 354 cases listed in Tables 2, 3, 4, and 5. This figure represents the number of instances in which no attempt was made to copy the act of the imitatee after the observational period.

A summary of the various types of imitative behavior for the separate problems is presented in Table 6. As will be noted, two arrays of scores are given for each type of activity listed. The first array for each rating shows the number of cases and percentage values for the entire group of 15 monkeys. The second array is based on the records of 9 animals only, the scores for the other 6 being eliminated because of the fact that they were so distracted by the imitatee during the tests that proper observation was not

TABLE 6

GROUP AVERAGES AND PERCENTAGES ON ALL PROBLEMS

R	Gr	Prob. I cases		Prob. II cases		Prob. III cases		Prob. IV cases		Total cases	
		No	%	No	%	No	%	No	%	No	%
I	15	35	41.6	48	53.3	37	41.1	44	48.9	164	46.3
I	9	23	47.9	48	88.9	37	68.5	44	81.5	152	72.4
P+	15	12	14.3	1	1.1	7	7.8	2	2.2	22	6.2
P+	9	3	6.2	1	1.9	7	13.0	2	3.7	13	6.2
P	15	10	11.9	1	1.1	4	4.4	6	6.7	21	5.9
P	9	5	10.4	0	0.0	2	3.7	3	5.6	10	4.8
P—	15	14	16.7	16	17.8	13	14.4	17	18.9	60	16.9
P—	9	10	20.9	4	7.4	6	11.1	5	9.3	25	11.9
F	15	13	15.5	24	26.7	29	32.2	21	27.8	87	24.6
F	9	7	14.6	1	1.9	2	3.7	0	0.0	10	4.8

The first array for each rating is the average score for the 15 animals, the second array is the average of 9 animals after eliminating 6 that were distracted by the imitatee.

For the meaning of the letter ratings (R) see Page 112.

afforded. As noted in the protocols, the 6 monkeys so excluded (F, G, H, S, T, V) were strongly influenced by the sex drive when in the apparatus. This was shown by undue attention to the imitatee, masturbation, "presentation" to imitatee, etc. The three females of this group (S, T, V) showed definite signs of sexual maturity as pointed out in Table 1. It may well be argued that the second array of scores (based on 9 animals only) is more representative of the imitative capacity in monkeys than the first array. Naturally the 6 animals that were distracted by the sex factor, so that they did not observe the solution of the problems, could not be expected to imitate. As indicated in Table 6, the imitation scores for the 9 observing animals were much higher than for the group as a whole. The score for immediate imitation rises from 46.3 per cent to 72.4 per cent, while the score for failures drops from 24.6 per cent to 4.8 per cent.

The difference between the distracted group and the 9 animals which apparently possessed the normal observational set is further emphasized by the computations of Table 7. Here the monkeys are listed in order according to the total number of immediate imita-

TABLE 7

SHOWING THE RECORD (IMMEDIATE IMITATION) OF EACH ANIMAL ON THE FOUR PROBLEMS IN TERMS OF AVERAGE SCORES

Animal	Prob. I		Prob. II		Prob. III		Prob. IV		Totals	
	No. cases	Av. sec	No. cases	Av. sec	No. cases	Av. sec	No. cases	Av. sec	No. cases	% suc
R	5	21.0	6	14.8	6	22.3	6	17.5	23	95.8
C	4	31.0	6	4.5	2	54.5	6	18.8	18	75.0
W	3	26.0	3	6.0	6	20.0	6	16.5	18	75.0
E	1	60.0	6	6.8	4	43.5	6	22.8	17	70.3
B	4	18.2	5	11.2	2	38.5	6	14.7	17	70.3
U	1	1.0	5	9.8	6	6.0	5	11.4	17	70.3
A	1	49.0	6	9.2	2	32.5	6	27.8	15	62.5
X	4	48.7	5	14.6	3	19.3	3	25.3	15	62.5
D			6	12.8	6	15.5	0		12	66.7
H	6	24.8	0		0		0		6	25.0
F	2	18.5	0		0		0		2	8.3
G	2	52.5	0		0		0		2	8.3
T	1	60.0	0		0		0		1	4.2
V	1	8.0	0		0		0		1	4.2
S	0		0		0		0		0	0.0

The first 9 animals comprise the satisfactory group; the last 6 subjects the distracted group. Animal D was not tested on problem I tions exhibited. A fairly definite gap occurs between the first 9 animals and the last 6 animals. The former individuals range from 66.7 per cent to 95.8 per cent in immediate imitation score when all four problems are pooled (24 tests). The monkeys of the distracted group show a range of from 0 to 25 per cent. This difference in score would seem to be explained by the dominance of sexual behavior in the case of the latter group. In spite of this fact, it seems rather remarkable that only one of the monkeys failed to show at least one instance of immediate imitation on the 24 tests. The high score of the best monkey of the group as a whole (23 instances of immediate imitation out of 24 tests) is likewise remarkable. It is still more significant, perhaps, that an animal was more likely than not to imitate successfully provided it was not distracted by the sexual factor.

It is impossible to draw a significant conclusion regarding a possible sex difference in imitative capacity in monkeys from our results because of the small size of the groups. However, it seemed worth while to compute the scores for immediate imitation for the sexes separately. These are shown in Table 8. As will be seen, the number of cases is much the same for males and females when the scores for all problems are pooled. There were 8 males and 7 females tested. Each of these groups included 3 of the sexually distracted animals so that the averages are reasonably fair for the two sexes. The slight difference in favor of the males is probably not significant. As a matter of fact there is little or no reason to suspect a sex difference in observational learning in monkeys.

TABLE 8

SHOWING RELATION BETWEEN SEX AND IMMEDIATE IMITATION SCORE

Problem	I	II	III	IV	Total
Males	2.3	4.1	2.3	3.4	11.9
Females	2.6	2.4	2.6	2.5	10.1

The scores on the separate problems are the averages for all the animals of one sex on 6 tests, the total score is based upon 24 tests

The relationship between age and immediate imitation score is indicated in Table 9. The group was too small and the age range too narrow to offer much in the way of analysis. The exact age

TABLE 9
SHOWING THE RELATION BETWEEN AGE AND IMMEDIATE IMITATION SCORE (ALL PROBLEMS)

Monkey	Score	Age
R	23	34
C	18	39
W	18	40
B	17	40
U	17	41
E	17	44
X	15	42
A	15	40
D	12	45
H	6	42
G	2	36
F	2	40
T	1	45
U	1	37
S	0	46
	Rank correlation —.35	

of the monkeys was unknown since the animals were purchased from dealers. According to our estimate (5), the range was from 34 to 46 months. On the whole, the younger animals made higher scores in the tests than the older animals, as shown by the rank correlation (—.35) of Table 9. It seems likely, however, that the age factor was merely incidental in this connection. The sexually distracted animals ranked somewhat above the average for the group in age. Some of the older animals also appeared to be timid, pugnacious, or less well tamed than the younger ones. It seems probable, therefore, that the apparent age difference merely reflects these emotional factors rather than a genuine divergence in imitative capacity.

In the above discussion we have referred to all cases of success within the 60-second test period as immediate imitation. In many instances, however, the imitative act occurred within a few seconds after observation of the imitatee. The directness or speed of all of the reactions is shown in Table 10. In 79 out of the 164 cases of success on all problems the act occurred in 10 seconds or less. The speed of such reactions ruled out the possibility of much trial-and-error behavior. In many instances at least the pattern of the required set of movements appeared to be grasped wholly through observation

TABLE 10

SHOWING THE TEMPORAL DISTRIBUTION OF IMMEDIATE IMITATION SCORES WITHIN THE TEST PERIOD (60 SEC.)

Time interval (seconds)	Frequencies Problem I	Problem II	Problem III	Problem IV	All problems
0— 1	2	4	1	0	7
1— 2	2	13	0	1	16
2— 3	0	5	3	0	8
3— 4	1	2	0	2	5
4— 5	1	4	0	2	7
5— 6	0	1	4	2	7
6— 7	1	1	0	2	4
7— 8	1	1	5	4	11
8— 9	1	2	0	3	6
9—10	1	4	2	1	8
10—15	2	4	4	5	15
16—20	2	1	3	5	11
21—25	3	1	2	7	13
26—30	2	0	0	2	4
31—35	1	1	0	1	3
36—40	2	0	5	2	9
41—45	1	0	1	2	4
46—50	4	2	0	0	6
51—55	3	1	4	2	10
56—60	5	1	3	1	10
Median time	26.2	4.3	14.4	15.0	11.0

Approximately 47 per cent of the successes, when the results of all problems are pooled, took place within 10 seconds. About 75 per cent occurred within 30 seconds. It thus appears that most of the reactions classed as immediate imitation were quite direct and speedy. This means that observational cues rather than trial-and-error activities largely determined the solution. It should be remarked, in this connection, that even the full 60-second test period is extremely short as compared with periods usually allowed by previous experimenters.

As has been noted, each animal was tested twice daily for 3 days on a given problem before passing to the next task. The question arose as to the influence of practice from one test period to another. An analysis of this factor is shown in Table 11. The number of cases of immediate imitation, together with the average time of performance, is given for each of the 6 tests. These data are indicated separately for the several problems. It is obvious that practice effects might be manifested either in a greater number of successes or in

TABLE 11

SHOWING THE PRACTICE EFFECT (THROUGH SIX TESTS) ON IMMEDIATE IMITATION

	Test 1		Test 2		Test 3		Test 4		Test 5		Test 6		Total	
Problem	I	Sec.	I	Sec.	I	Sec	I	Sec.	I	Sec.	I	Sec.	I	Sec.
I	4	50.7	4	21.0	4	24.2	8	28.1	8	36.1	7	20.9	35	29.8
II	5	27.4	8	23.9	8	5.6	9	4.0	9	4.0	9	4.3	48	10.1
III	8	18.0	5	12.6	4	33.0	6	29.2	7	22.4	7	27.9	37	23.4
IV	7	29.0	7	22.3	7	15.3	8	20.2	7	14.4	8	13.5	44	19.0
Total	24		24		23		31		31		31		164	

I refers to the number of cases of immediate imitation for all animals, Sec to the average time in seconds for imitation speedier reactions in the later tests on a given task That is, fewer imitations should appear on test 1 than on test 6 and the average performance time should be longer. As will be seen, the results are not very consistent in this respect. Apparently the practice effect was greater on problems I and II than on problems III and IV In the case of problem III the largest number of imitations actually occurred on the first test, while the performance time was shorter than that for most of the later tests. Even when practice effect is indicated, it is impossible to say whether it operated to bring about better observation or a smoother manipulation of the puzzle device

As noted above, 14 of our animals had been used by Fjeld (5) in determining the limits of learning in the monkey by means of the Jenkins problem box. It is possible, therefore, to compare these animals in terms of their limits score and their imitation score The former score refers to the number of steps which could be mastered in the progressively complex pattern provided by the Jenkins apparatus The two kinds of scores for each monkey are indicated in Table 12 The rank correlation obtained (—.13) suggests that the two types of task measure different behavioral functions. Such a conclusion can be only tentative, however, in view of the small size of this group It is interesting to note that the animal making

TABLE 12
SHOWING CORRELATION BETWEEN IMMEDIATE IMITATION SCORE AND LEVEL OF PERFORMANCE ON JENKINS PROBLEM BOX (Fjeld's results)

Monkey	Limit on problem box	Imitation score
A	22 steps	15
V	13 steps	1
B	12 steps	17
E	12 steps	17
F	9 steps	2
X	8 steps	15
G	6 steps	2
U	4 steps	17
W	4 steps	18
C	3 steps	18
D	3 steps	12
S	3 steps	0
T	3 steps	1
R	2 steps	23

Rank correlation— 13

the lowest score on the Jenkins apparatus made the highest score on immediate imitation It is fairly obvious that the Jenkins apparatus and the imitation tests emphasize essentially different types of response The former certainly does not stress observational cues to the same extent as the latter Moreover, the emotional influence arising from the presence of another animal is altogether absent. Both the limits score and the imitation score may be regarded as indices of one or another aspect of intelligence.

The positive results on imitation in the monkey here reported seem strangely at variance with the findings of previous investigators This is all the more striking in view of the fact that more rigid controls were applied in our work than had been used heretofore. The criteria of imitation set forth in the introductory section of this paper were fulfilled to the letter. The tasks employed were sufficiently novel and complex to involve a genuine learning process; the responses classed as immediate imitation appeared promptly after observation of the imitatee; previous practice was excluded by the experimental conditions, the response of the imitator was substantially that of the imitatee; and a large enough number of instances occurred on various problems to eliminate the chance factor Few instances of immediate imitation in the monkey have been reported by previous workers even when their technique did not meet the rigid criteria here applied.

It may well be that the negative results of previous workers on the monkey resulted from the use of a faulty method. The Observation-Cage method has usually been employed and the main faults of this method have already been pointed out. The Duplicate-Cage method here employed offers many advantages in the way of providing a proper setting for the operation of observational cues The usual delay between observation and the imitative act is eliminated and the shifting about of the animals is unnecessary. Moreover, a clear profile view of the imitatee at work at the task is provided by the appropriate arrangement of the panels. In addition to this difference in general method, it seems likely that our monkeys were tamer and better adjusted to laboratory conditions than has been true in most previous work on imitation. They had been trained extensively on the Jenkins apparatus. It may be remarked, however, that this previous experience gave them no aid in solving the imitation problems, since the latter were all essentially different from the reaction required in the Jenkins apparatus.

It would seem that the current opinion that monkeys possess little or no capacity to imitate must be revised in the light of our results. In fact it is clear that when monkeys are given the proper setting for observation they exhibit at once a strong tendency to imitate their fellows. This is true at least of animals well adjusted to laboratory situations as, of course, they should be. Moreover, it appears that observational learning is much more economical than ordinary trial-and-error learning for monkeys as for men

SUMMARY

1. Fifteen rhesus monkeys were tested for imitation by means of a newly devised procedure (Warden Duplicate-Cage method) on four manipulative problems, six tests being given on each task.
2. Immediate imitation (success within 60 seconds) occurred in 46.3 per cent of the 354 tests; this figure is raised to 72.4 per cent when the records of 6 animals are eliminated because of serious sexual distractions The best animal imitated in 23 out of 24 tests given it.
3. No significant differences were found when sex and age comparisons were made.
4. The low correlation (—.13) between imitation score and limits score on the Jenkins problem box suggests that these two types of tests measure divergent aspects of intelligence in the monkey

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LE COMPORTEMENT IMITATIF CHEZ LE SINGE RHÉSUS

(Résumé)

On décrit une méthode nouvelle de tester le comportement imitatif chez les animaux (la méthode des Cages Doubles de Warden) où le retard et les actions de changer de celui à imiter et de l'imitateur sont éliminés On a fait subir à chacun de singes rhésus, bien adaptés aux situations du laboratoire, 6 tests sur les 4 tâches suivantes de manipulation pour obtenir de la nourriture. (1) le tirage d'une ficelle, (2) l'ouverture d'une porte par le bouton, (3) l'ouverture de la porte après avoir manipulé un loquet, (4) l'ouverture de la porte après avoir manipulé deux loquets On a découvert une forte tendance à imiter promptement quand on s'est servi d'un autre singe comme celui à imiter L'imitation immédiate (le succès en 6 secondes) s'est montrée en 46,3 pour cent des 354 tests. Ce chiffre devient 73,4 pour cent quand on élimine les résultats de 6 des 15 animaux à cause des distractions sérieuses sexuelles Le meilleur animal a imité en 23 sur les 24 tests subis On n'a trouvé aucunes différences signifiantes ni de sexe ni d'âge. La corrélation peu élevée (—0,13) entre le résultat

de l'imitation et les limites du résultat de l'apprentissage x dans la boîte à problèmes de Jenkins (5) suggère que ces deux types de test mesurent des aspects divergents de l'intelligence chez le singe Les résultats positifs ici obtenus sont les contraires de ceux antérieurement obtenus dans des tests de l'imitation chez le singe Il paraît probable que la méthode nouvelle fournit une situation plus satisfaisante pour l'observation que l'ancienne méthode de la Cage d'Observation Cette étude montre que l'apprentissage par l'observation est beaucoup plus économique que l'apprentissage par essais-erreurs chez le singe ainsi que chez l'homme

Warden et Jackson

DAS NACHAHMUNGSVERHALTEN BEI DEM RHESUS AFFEN

(Referat)

Ein neues Verfahren zur Prüfung des Nachahmungsverhaltens bei Tieren wird beschrieben (Warden Doppelkafigmethode), in dem die Verzogerung und Verschiebung des Nachgeahmten und des Nachahmenden ausgeschaltet werden Funfzehn Rhesus Affen, die sich den Laboratoriumsituationen angepasst haben, bekamen je 6 Tests bei den vier folgenden Handhabungsaufgaben, um Futter zu erreichen (1) das Ziehen eines Fadens, (2) das Öffnen einer Tur durch einen Turknopf, (3) das Öffnen einer Tur nach der Bewegung einer Klinke, (4) das Öffnen der Tur nach Bewegung zwei Klinken Eine starke Tendenz zum sofortigen Nachahmen zeigte sich, wenn ein anderer Affe als der Nachgeahmte diente. Die sofortige Nachahmung (Erfolg innerhalb 6 Sekunden) erfolgte in 46,3 Prozent der 354 Falle Diese Zahl wird auf 73,4 Prozent erhoht, wenn die Ergebnisse von 6 der 15 Tiere ausgestossen werden, weil sie die Folge ernster sexueller Ablenkungen waren Das beste Tier ahmte in 23 von den 24 Versuchen nach Keine bedeutsamen Geschlechts- oder Altersunterschiede zeigten sich Die niedrige Korrelation (—0,13) zwischen dem Nachahmungswert und den Grenzen des x-Lernwertes bei dem Jenkins Problemkasten (5) weist darauf hin, dass diese beiden Typen von Prufung die abweichenden Seiten der Intelligenz beim Affen misst Die positiven Ergebnisse stellen sich den fruheren Nachahmungsversuchen bei Affen entgegen Es scheint wahrscheinlich, dass die neue Methode eine befriedigendere Beobachtungssituations verschafft als die alte Beobachtungskafigmethode Das vorliegende Studium beweist, dass das Beobachtungslernen okonomischer sei als das Versuch- und Irrtumlernen beim Affen wie beim Menschen

Warden und Jackson

A PRELIMINARY STUDY OF THE HUNGER DRIVE IN THE RHESUS MONKEY[1]

From the Laboratory of Comparative Psychology, Columbia University

C J WARDEN AND T. A JACKSON[2]

The present report represents an attempt to extend the Obstruction method of drive analysis to the monkey It should be regarded as a preliminary study inasmuch as it is limited to the hunger drive and, even as thus restricted, is far from exhaustive. In fact, the primary aim of the investigation was to standardize the procedure to be followed in a systematic application of the method to the monkey. It is obvious that an extensive analysis of drives in the monkey, comparable to that carried out in the Columbia laboratory on the white rat (2), would extend over a period of years. The hunger drive was selected for preliminary study because it appeared to offer the least difficulty in the way of experimental controls. Our present findings seem to indicate that the Obstruction method, with minor modifications in procedure, can be usefully applied to many of the higher animals.

THE METHOD

The apparatus differed in numerous details from that described by Warden (2) in connection with the work on the white rat. The new model Obstruction apparatus was devised by Jenkins and Warden to eliminate certain objectionable features of their first model. The changes made have been discussed in another connection (3) and need not be repeated here The design of the new model in a size suitable for the monkey is shown in Figure 1. It was found advisable, after preliminary tests, to remove the swinging one-way

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[1] This report covers one major topic in the project of Motivation and Intelligence in the Rhesus Monkey (under the direction of Professor C J. Warden), supported by the Council for Research in the Social Sciences of Columbia University

[2] This study was planned in cooperation. The data were taken and computed by the junior author and the final report written by the senior author

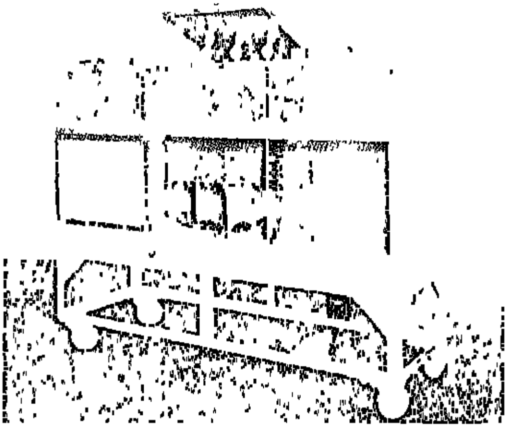

FIGURE 1

JENKINS-WARDEN OBSTRUCTION APPARATUS

Entrance and incentive compartments, approximately 24 inches in all dimensions, are separated by a 30-inch tunnel with grid floor The door in the center of the tunnel was removed and the grid lengthened to 30 inches Light from the chambers above was diffused by passing through opal and plate glass surfaces to the compartments below The front of the entire apparatus was covered by a one-way light screen One door and part of the light screen were removed in taking the above photograph

(Courtesy of C J Warden)

door of the center compartment and extend the grid throughout the entire length of this section The monkeys were prevented from jumping across the grid without getting a shock by a proper adjustment of the top of the tunnel Since the animals varied somewhat in size, it was necessary to work out this adjustment for each monkey separately This arrangement insured that an animal would need to make contact with the grid in passing through the tunnel to the incentive beyond The grid was divided into 3 sections along its length and each section supplied from independent current sources This insured that an animal would receive a minimum of three shocks in crossing the grid

Some two months or more of preliminary tests were necessary to determine an optimum strength of shock for use in the later experiment These tests were made on monkeys of the same size as those employed in the experiment proper. An optimum shock may be regarded as one which is sufficiently strong to induce hesitation before crossing but not strong enough to prevent crossing. In the last analysis, the experimenter must decide as to the precise shock to be used on the basis of a large number of empirical observations. The Jenkins electrical stimulation system (3, Figure 11) was utilized for supplying the grid with a variety of shocks from which the selection could be made. This system provides electrical stimuli of known form, voltage, and current value throughout a very wide range. The shock finally selected as the optimum was that given by a current of 0.6 milliamperes set at 600 volts, the external resistance being 1,000,000 ohms. Each of the 3 monkeys tested would cross the grid at this strength, the crossing time varying from 2 seconds to 3 minutes. The use of high voltage current with high external resistance, as indicated elsewhere (2), is advisable in work

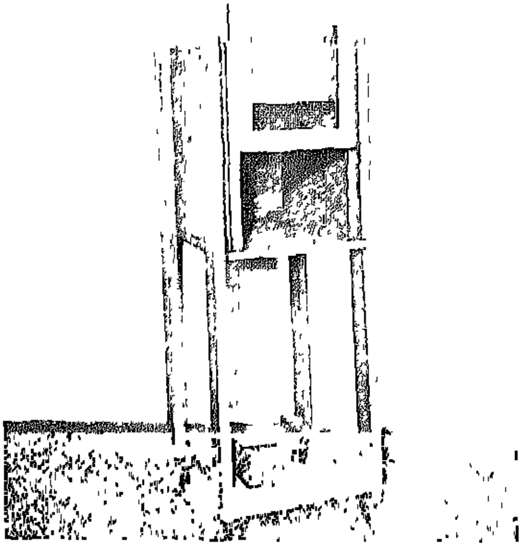

FIGURE 2

CARRIAGE USED IN TRANSPORTING THE MONKEYS of this sort, since it tends to decrease the influence of the factor of individual differences in skin resistance.

The general procedure differed in numerous ways from that employed in testing the white rat Each monkey was transferred from the vivarium to the experimental room in the carriage illustrated in Figure 2. This carriage was also used in returning the animal from the incentive compartment to the entrance compartment after a given test This procedure eliminated all handling of the animals during the test. The monkeys were very tame and jumped into and out of the carriage promptly whenever the experimenter raised the door. The chain worn in the living cage was unsnapped from the belt before taking them into the experimental room. Each animal was allowed to become well adjusted to the apparatus and routine before being tested This period of adjustment (10-20 minutes) continued from 1 to 4 days, and was considered complete when the animal acted promptly in jumping in and out of the carriage and in crossing the grid (no shock) when the opportunity presented. On the first day of the regular tests, the animal was allowed to cross the grid 4 times without shock before the first trial proper (with shock), on later test days the preliminary runs were reduced to two. These non-shock crossings seemed necessary because of the long hesitation of the animal at the beginning of the series for a given day.

The use of a test period of standard length was found to be impractical with the monkey. The white rat reacts with fair promptness and consistency so that the number of crossings within a standard test period gives an excellent measure of strength of drive. The behavior of the monkey is much more variable and the time required to shift an animal from the incentive compartment to the entrance compartment by the carriage device varied considerably It seemed best, therefore, to standardize the number of crossings required and to take the score in terms of the time taken to cross the grid Obviously, a short crossing time indicates a strong drive under such a method of scoring The record of the crossing time was taken by means of a Bristol time recorder, one key being pressed when the door to the tunnel was opened and another when the animal reached the incentive compartment Opportunity to cross was limited to 300 seconds on each test, the animal being removed from the entrance compartment after this period had elapsed and a failure recorded The number of approaches and contacts (partial crossings) on each test were recorded. As in the case of the rat, *these scores apparently add nothing of value to the record and hence* have not been included in this report.

The 14 monkeys used in the experimental work proper are listed in Table 1 Some of these were employed in Experiment I and others in Experiment II Since the conditions of these two experiments differed in certain important respects, further details as to procedure will be discussed in connection with each separately.

TABLE 1

SHOWING SEX, WEIGHT, AND ESTIMATED AGE OF THE MONKEYS

Monkey	Sex	Weight (oz)	Est age (*mos*)
A	M	137	40
B	M	148	40
C	M	133	39
D	M	146	45
E	M	138	44
F	M	135	40
G	M	124	36
H	M	149	43
R	F	107	34
S	F	151	46
U	F	141	41
W	F	133	40
X	F	112	42
Y	F	146	42

EXPERIMENT I.

The aim was to determine the influence of the length of starvation period on the strength of the hunger drive. The 3 males (D, F, G) and 2 females (U, W) employed were well adjusted to laboratory situations They had been used extensively in problem-box (1) and imitation apparatus (4) before being utilized in the present experiment. The further regular routine involved in the specific adjustment of each animal to the motivation apparatus has already been described above. The tests were carried out in the early afternoon The several periods of starvation were begun in each case immediately following the main meal of the day. Although complete starvation was enforced during these periods, water was supplied twice daily to the cages. The procedure differed from that used earlier in the white rat study (2) in that the one group was tested at all periods of starvation. An interval of 4 days intervened, however, between these periods during which the monkeys were given their regular diet. This plan was used in order to minimize the possible cumulative effect of continued starvation. The incentive consisted of 2 raisins obtained by the monkey after each crossing of the grid.

The results secured are presented in Table 2. The average crossing time in seconds for the group is shown for each of the 10 crossings required. On account of the small size of the group, the variability is indicated only roughly in terms of the range. For the same reason, the averages cannot be taken too seriously and the conclusions drawn must be regarded as tentative. On the whole, the data seem to show that the hunger drive is less strong after an 8-hour starvation period than after the longer periods investigated. The average crossing time is about the same for the 24-, 36-, and 48-hour starvation periods. The range is greatly reduced, however, in the case of the two longer periods. If the average for the 8-hour period be compared with the combined average for all longer intervals, the critical ratio is found to be 2.76. This means that there are 99.7 chances in 100 that the difference between the two averages

TABLE 2

SHOWING THE CROSSING TIME IN SECONDS FOR THE GROUP (5 MONKEYS) AFTER DIFFERENT PERIODS OF STARVATION

Crossing	8 hrs.		24 hrs		36 hrs		48 hrs.	
No	Av	Range	Av	Range	Av	Range	Av	Range
1	8.0	2-35	4.2	2-11	8.2	2-18	4.0	3-5
2	4.1	2-10	4.0	2-10	5.4	3- 9	4.8	3-9
3	4.8	2-10	2.8	2- 5	4.8	2-10	4.2	2-9
4	7.7	2-28	5.2	1-15	5.2	2-14	4.4	2-7
5	13.6	2-79	3.4	2- 5	4.8	3-10	4.8	2-8
6	5.9	2-13	2.8	2- 4	4.0	2- 8	6.0	3-11
7	9.2	2-41	16.0	2-65	5.0	2-12	7.0	3-11
8	8.0	2-26	3.6	2- 6	2.6	1- 4	5.4	3-14
9	6.4	2-23	4.0	2-11	4.0	3- 7	7.4	3-14
10	10.0	2-58	3.4	2- 5	4.2	2-11	3.4	3-5
Average	7.77	2-35	4.94	1-65	4.82	1-18	5.14	2-14

is greater than zero. The tentative conclusion can thus be drawn that the hunger drive is stronger after the longer periods of starvation than after the shorter (8 hours).

It may be well to call attention to some of the shortcomings of the present experiment in the light of our earlier work on the Obstruction apparatus (2) in which the white rat was employed. In the first place, the experiment was not carried far enough to determine the length of starvation period associated with the optimum strength of hunger drive in the monkey In the second place, financial considerations made it quite impossible to use equivalent groups for each starvation period. It was necessary to employ the same group of monkeys in testing the several periods of starvation. As will be shown later, a series of retests involves a cumulative adaptation to the grid. For this and other reasons, our earlier procedure of using equivalent groups for each drive condition tested is recommended for the monkey as for the rat.

EXPERIMENT II

The purpose of this experiment was to obtain some evidence as to the influence of electric shock on the monkey under conditions somewhat different from those used in the standard procedure indicated above. It was hoped that these variations from the regular Obstruction-apparatus technique would throw some light upon the nature of the response elicited in connection with this method. The two main variations will be discussed separately.

Adaptation to the Standard Shock The optimum shock as determined for use in Experiment I was used in the present connection, and the period of starvation was 8 hours throughout. The factor studied was the adaptation effect induced by continued retesting of the animals in the apparatus under these conditions. The original test, as well as each of the retests, consisted of 15 crossings made at a single session. The sessions occurred at the rate of 1 per day except that a period of 1 week intervened between retests 4 and 5. The results for the 11 monkeys (5 males, 6 females) are given in Table 3. As will be seen, the crossing time shows a general tendency to decrease in length through the series of retests. This indicates that the monkey becomes adapted to the shock after repeated crossings and exhibits less hesitation The amount of adaptation is quite

TABLE 3
SHOWING THE CROSSING TIME IN SECONDS ON A SERIES OF RETESTS
(11 MONKEYS)

	Male		Female		Combined	
	Av	Range	Av	Range	Av	Range
Test	3 7	1- 41	13 6	1-184	8 9	1-184
Retest 1	8 2	1-143	7 1	1-109	7 7	1-143
Retest 2	4 3	1- 27	9 5	1- 98	7 2	1- 98
Retest 3	7 4	1- 60	6 2	1- 34	7 2	1- 60
Retest 4	3 5	1- 12	5 3	1- 28	4 4	1- 28
Retest 5	3 4	1- 21	9 5	1-158	6 8	1-158
Retest 6	3 1	1- 30	5.3	1- 18	4 2	1- 30
Retest 7	2 8	1- 23	4 7	1- 36	3 9	1- 36
Retest 8	2 9	1- 55	6 3	1-121	4 7	1-121
Retest 9	2 7	1- 15	4 0	1- 26	3 4	1- 26
Average	4 2	1-143	7 2	1-184	5 8	1-184

marked when a large number of crossings (150 in this case) are involved The rise in value on retest 5 (combined average) would seem to show that this adaptation to the shock is partially lost when an interval of 1 week intervenes between successive retests. These results tend to support the contention made above that equivalent groups should be employed in applying the Obstruction method to the monkey

The crossing time of the females is significantly longer than that of the males In fact the critical ratio of the difference (3 0 seconds) is 5 22 This difference is based upon the records of only 5 males and 6 females and may not be a true sex difference. The two groups were similar in most respects, but, on the whole, the females were somewhat lighter in weight than the males The average weight of the males was 140.4 oz and that of the females 131 7 oz This difference may have favored the males, since the effect of electric shock is known to be in part a function of the weight of the individual. The apparently greater sensitivity of the females to shock, as shown by long crossing time, may be due to the weight factor In any case, it would seem advisable to determine more specifically than was done here the weight-optimum shock relationship in applying the Obstruction method to monkeys

The rank position of the several animals on the original test and the later retests is shown in Table 4 In computing such positions the rank of 1 was given to the shortest crossing-time score, etc. It

TABLE 4

SHOWING THE RANK POSITION OF THE INDIVIDUALS ON THE SERIES OF RETESTS IN TERMS OF CROSSING TIME IN SECONDS

						Animal					
	A	B	C	D	E	R	S	U	W	X	Y
Test	–	1	6	4	2	8	9	5	10	7	3
Retest 1	9	1	7	3	10	6	11	2	8	5	4
Retest 2	5	3	6	7	4	2	11	9	10	8	1
Retest 3	2	9	6	7	5	3	10	8	—	4	1
Retest 4	4	2	5	8	6	3	10	9	7	—	1
Retest 5	7	1	6	4	5	8	11	9	10	3	2
Retest 6	5	1	6	7	3	4	10	9	8	2	—
Retest 7	4	1	5	10	2	9	11	6	8	1	3
Retest 8	5	1	2	9	4	3	11	6	8	7	10
Retest 9	5	1	3	10	7	9	11	4	6	8	2
Av. rank	5.1	2.1	5.2	6.9	4.8	5.5	10.5	6.7	8.3	5.0	3.0

Blanks in table indicate that animal refused to work.
Rank 1 is given to the lowest crossing score in terms of seconds.

is clear that the rate of adaptation arising from the series of retests varied greatly from one monkey to another. Moreover, the rank positions on the original tests are not maintained with consistency on the later retests. In fact, the rank correlation between position on the test and the positions on the 9 retests is only +.36. These results tend to confirm the conclusions drawn from the absolute scores presented in Table 3.

Adaptation to a Progressively Increasing Shock. As commonly used, the Obstruction method calls for a constant and optimum shock. Nevertheless, it seemed of interest to determine the influence of a varying shock upon the activity of crossing the grid. The current was raised from one crossing to another, through a series of 20 crossings, by increments of 10 per cent, as indicated in the second column of Table 5. The entire series of crossings occupied a single test period. The record for each animal in terms of the crossing time in seconds is given in Table 5. All but 3 of the 12 monkeys continued to cross, within the 300-second limit imposed, at the 30th trial (m.a., 7.93, 991.2v., ext. resist. 125,000 ohms) but these data were omitted from the table because of the difficulty of computing averages. The immediate adaptation to the shock was remarkably consistent in the case of some of the monkeys (Y, X, U, etc.) as shown by the short crossing time. It is evident that the

TABLE 5

Showing the Effect of Gradual Increase of the Strength of Shock on the Length of Crossing Time (in seconds)

Cross No	Milli-amps	Animal												
		A	B	C	D	F	G	H	R	U	W	X	Y	Av
1	0 50	4	2	1	6	3	2	9	4	3	10	2	2	4 0
2	0 55	6	2	1	8	2	2	9	3	3	4	2	2	3.7
3	0 61	3	2	2	18	2	3	16	2	2	5	2	2	4.9
4	0 67	2	1	1	6	2	2	5	2	2	5	2	2	2 7
5	0 73	3	1	1	5	2	2	6	2	4	5	2	2	2 9
6	0 81	22	1	1	6	2	2	9	2	3	8	2	2	5 0
7	0 89	4	1	1	22	3	2	16	2	4	2	2	2	5 1
8	0 97	9	1	1	6	3	2	7	2	3	3	2	2	3 4
9	1.07	7	1	3	8	2	3	6	2	3	2	4	2	3 6
10	1 18	4	1	2	18	2	3	30	2	5	5	3	2	6 4
11	1 30	17	2	1	5	3	6	6	2	3	2	2	2	4 3
12	1.43	3	2	13	4	2	3	12	2	4	8	2	2	4 7
13	1 57	4	1	7	13	3	18	42	3	2	6	4	2	8 7
14	1.73	2	4	2	11	2	6	21	55	2	6	4	2	9 7
15	1 90	12	24	5	4	71	13	18	9	3	2	4	2	13 9
16	2 09	4	84	22	3	13	14	7	31	2	4	2	2	15 7
17	2 30	3	61	11	4	3	7	107	116	4	7	2	2	27 2
18	2 53	4	28	2	4	3	25	29	5	4	4	2	2	9.3
19	2 78	3	57	49	4	3	8	165	10	3	8	2	2	26.2
20	3 06	3	300	2	3	3	55	133	4	2	2	2	2	42 6

The calculated current was raised by increments of 10% through the series of crossings The external resistance ran as follows crossings 1-8, 1,000,000 ohms, crossings 9-16, 500,000 ohms, crossings 17-20, 250,000 ohms The voltage was adjusted between 500-1000 v so as to give the required ampere reading at a given resistance step.

monkey becomes readily adapted to a very strong shock when the increments of current increase are relatively small. It should be stated, however, that the monkeys tested had already been used extensively in various other situations in which shocks of moderate intensity had been employed. Doubtless this accounts in part for the ready adaptation of the animals to the higher degrees of shock included in our series.

Comparisons

Little is known at present regarding the relative ability of individual monkeys on different types of task The project (see footnote p 126) carried on in the Columbia laboratory during the past several years makes a few such comparisons possible Scores were obtained on 10 monkeys for the following 3 or more less distinct types of task: (1) Jenkins problem box, (2) Warden Duplicate-Cage imitation apparatus, and (3) Obstruction apparatus, hunger-drive. The tests were carried out in the order here indicated. The scores for the 10 monkeys are given in Table 6. The hunger-drive score is based upon the 8-hour starvation period and hence is not the maximum value for this drive. The problem-box score is the number of steps that the animal could learn in the Jenkins apparatus (1). The imitation score represents the number of cases of immediate imitation on the Duplicate-Cage apparatus (4). Since only 10 individuals are included in the comparisons, merely tentative conclusions can be drawn.

TABLE 6

SHOWING RELATION BETWEEN DRIVE SCORE (8 HRS. STARVATION) AND RATINGS ON PROBLEM-BOX AND IMITATION TESTS

Monkey	Drive (hunger)	Problem box (limits)	Imitation (immediate)
B	1.3 sec	12 steps	17 cases
E	1.4	12	17
A	4.1	22	15
D	4.6	3	12
U	5.9	4	17
C	7.9	3	18
X	15.1	8	15
R	16.1	2	23
S	18.5	3	0
W	22.6	4	18
Rank correl.	Drive	Problem box	+.63
	Drive	Imitation	—.11
	Problem box	Imitation	—.17

In computing the above correlations, the following scores were given the rank of 1. Drive—shortest crossing time; Problem box—largest number of steps on Jenkins' apparatus, Imitation—largest number of cases of immediate imitation on Warden Duplicate-Cage apparatus.

The rank correlation between the drive score and the problem-box score is positive but not very high (+.63). The degree of hunger was that resulting from an 8-hour starvation period in both tests. Perhaps the correlation would have been higher if the optimum starvation period (not yet determined) had been employed in both situations. In any case, there would seem to be a fairly important relationship between strength of hunger drive and the ability to form a complex pattern of response in the Jenkins apparatus. The imitation score gives a small negative correlation with both of the other test scores. It is obvious that strong arousal and persistence were not required in the imitation test, since only 60 seconds were allowed in which to act. This further comparison corroborates the conclusion previously drawn (4) that observational learning is markedly different in type from the usual trial-and-error activity of a problem box. Perceptual capacity rather than persistent activity is the important thing in the imitative solutions of problems

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UNE ÉTUDE PRÉLIMINAIRE DE L'IMPULSION DE FAIM CHEZ LE SINGE RHÉSUS

(Résumé)

Cette étude représente le premier essai pour étendre l'emploi de la méthode d'Obstruction de Columbia au singe On appuie principalement dans ce rapport préliminaire sur le processus plutôt que sur les vrais résultats Dans la première expérience il s'agit de la mesure de la force de l'impulsion de faim après 8, 24, 36, et 48 heures sans nourriture La plus courte période sans nourriture a produit une plus faible impulsion, en termes du temps du traversement, que les plus longues périodes On n'a pas déterminé la relation optimum entre l'impulsion et le manque de nourriture On n'a pu arriver à d'autres conclusions parce qu'on n'a pas employé la méthode des groupes équivalents Dans l'expérience 2, on a montré que les singes s'adaptent facilement au choc optimum quand ils subissent un nouveau test chaque jour pendant quelque temps Ils s'adaptent facilement aussi à des chocs très sévères quand on fait monter la valeur du courant par des croissances de 10 pour cent dans une série de 20 traversements donnée à une période de travail On a trouvé une corrélation de range de +0,63 entre le résultat de l'impulsion de faim (8 heures sans nourriture) et le résultat des limites dans la boîte à problèmes de Jenkins comme déterminé par Fjeld (1) Le résultat de l'impulsion de faim et le résultat de la boîte à problèmes ont montré une petite corrélation négative avec un résultat de l'imitation immédiate comme dé-

terminée par la méthode des Cages Doubles (4) On a basé ces corrélations sur les résultats de 10 singes seulement On suggère que la capacité d'observer plutôt que l'activité persistante est importante pour l'imitation réussie

WARDEN ET JACKSON

EIN VORSTUDIUM DES HUNGERTRIEBES BEIM RHESUS AFFEN

(Referat)

Dieses Studium stellt der erste Versuch dar, die Columbia Hindernismethode beim Affen anzuwenden Die Hauptbetonung in diesem Vorbericht wird auf das Verfahren eher als auf die tatsachlichen Ergebnisse gelegt. Das erste Experiment beschaftigt sich mit der Messung des Hungertriebes nach 8, 24, 36 und 48 Stunden der Futterentziehung. Die kleinere Periode der Futterentziehung ergab einen schwacheren Trieb in bezug auf die Zeit des Laufens als die langeren Perioden. Das gunstigste Trieb-Hungerverhaltnis wurde nicht erfahren Weitere Schlusse konnten nicht gezogen werden, weil die Methode der gleichen Gruppen nicht verwandt wurde In Experiment 2 wurde nachgewiesen, dass die Affen sich schnell an den gunstigsten elektrischen Schlag anpassen, wenn sie eine Zeitlang jeden Tag wiedergepruft wurden. Auch passten sie sich schnell an sehr starke elektrische Schlage, wenn der Stromwert durch Zunahmen von 10 Prozent bei einer Reihe von 20 Laufen, die bei einer Arbeitsperiode gemacht wurden, erhoht wird. Eine Rangkorrelation von +0,63 zwischen dem Hungertriebwert (8 Stunden Futterentziehung) und den Grenzenwert bei dem Jenkins Problemkasten, wie Fjeld (1) ihn bestimmt hat, zeigte sich Sowohl der Hungertriebwert wie der Problemkastenwert zeigten eine kleine negative Korrelation mit dem sofortigen Nachahmungswert, der durch die Doppelkafigmethode bestimmt wurde (4) Diese Korrelationen fussten auf den Werten von nur 10 Affen. Es wird vorgeschlagen, dass die Beobachtungsfahigkeit eher als die beharrliche Tatigkeit wichtig für erfolgreiche Nachahmung sei

WARDEN UND JACKSON

AN ANALYSIS OF CERTAIN FORMS OF SO-CALLED "NERVOUS HABITS" IN YOUNG CHILDREN*

From the Department of Home Economics and Household Administration, University of Chicago

HELEN LOIS KOCH

INTRODUCTION

Terminology. The fact that so much disagreement exists in regard even to the name appropriate for the objects of this study attests to our lack of understanding of their nature or significance. The terms "automatism," "nervous habit," "tic," "mannerism," "habit spasm," and "idiosyncrasy" have all been applied. Each designation carries certain implications which are, doubtless, questionable The label, "movement mannerism," probably commits us to least regarding the nature of the act itself or its causes, and hence is perhaps the most defensible at this stage Since, however, the appellation, "nervous habit," more successfully conveys to the average reader an idea of the phenomena we are exploring, we have used it in the title of this paper with the qualifying "so-called." We maintain, however, that the relation, or degree of relation, to nervousness of some at least of the behavior patterns we are focusing upon needs to be demonstrated. We even question the second member of the label, for we do not know how nearly invariable, frequent, or automatic an adjustment must be to deserve the designation, "habit."

The problems we have set for ourselves, to state them briefly, are as follows·

1. The development and testing for reliability of a technique for describing the relative frequency with which young children tend to indulge in a variety of classes of, superficially at least, simple, patterned, brief, more or less individual, body-directed adjustments To say these are purposeless, automatic, or habitual carries us beyond limits which our observations justify

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*Accepted for publication by Carl Murchison of the Editorial Board and received in the Editorial Office, June 8, 1934

2 The determination of the relative stability of the behavior tendencies under consideration.

3. An investigation of the relationship of the frequency of the mannerisms noted to variables such as certain socially significant behavior trends, particular home conditions and attitudes, sex, age, IQ, and type of situation under which the subjects are observed.

4 An analysis by the Thurstone multiple factor method (8) of the inter-index correlations in order to discover whether there is any evidence justifying the assumption of such a general factor as nervousness [1]

METHOD

Categories. The specific response patterns we chose to analyse and the classification scheme employed were rather arbitrarily determined. We had in mind in our selection acquiring data concerning forms of behavior frequently referred to as "nervous habits," as well as upon other equally obvious and seemingly parallel types usually neglected.

Eleven classes of activities covering a considerable range of patterns were studied They included such as the subsequent· blinking vigorously (employing clearly more than the *orbicularis oculi* muscle) or rubbing the eyes, standing on the sides of the feet; playing with the fingers, manipulating the scalp or hair, sucking, biting, or chewing on things not intended for consumption; rubbing the ears, handling or wrinkling the nose, squirming or tugging nonmanually at clothing (labelled "corporal-mass"), sniffing (labelled "respiratory"), masturbating either by means of manual stimulation or thigh rubbing, and finally, stroking or handling in a definite, limited, body-directed way some part of the corpus other than those already specified in the other categories (labelled "corporal-limited") As must be apparent, we tended, in general, to put into one class adjustments to which it seemed the major stimulus might be received from a particular part of the anatomy, though we make no pretense of being sure of the locus of the focal phases of the conditions antecedent to the responses we were studying. Squirming or tugging at clothing is somewhat in contrast with the other categories in that mass activity, rather than the more circumscribed, generally was characteristic of the adjustment. The category, corporal-limited, differs still more from the others in that we used it as a sort of catch-all. What effects the fineness or lack of fineness in our classification scheme has engendered, we do not know

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[1] This part of the study will be reported in a second paper

A number of our activity groups were so defined as to include mannerisms involving the use of the hands. This, for a time, was a matter of some concern to us, since an individual's score for a category was to be determined merely by the number of mannerisms noted during 400 half-minutes The employment of the hands in the relief of discomforts in various parts of the body was so nearly the rule, however, we feared if we limited our consideration to the handling of a limited part of the anatomy, that much that was of significance to us would be overlooked To have included all manual activities would, on the other hand, have embraced too much. Of course a zero score, it should be remembered, was possible for any period of time and frequently occurred Not only, moreover, could several parts of the body be manipulated by the human child, since it has two hands, but also the interval of observation was long enough for an individual to indulge in several forms of quite diverse manual manipulations. In the light of these considerations we have felt it safe to continue with categories in which the response patterns might overlap, in that the same body member could be employed Some of our categories we have defined in such a way, however, as to avoid involving the manual members in the response Standing on the sides of the foot, squirming, and sniffing are cases in point. When questions arise which may be complicated by the possible overlap just mentioned, a special analysis will be made of the non-controversial cases.

As has been previously stated, we make no claims with respect to the automatic nature of the phenomena we observed We choose merely to observe the relative frequency with which certain parts of the anatomy were involved in a limited range of body-directed adjustment patterns in children Habitualness may be defined, perhaps, in terms of our frequency counts, but we confess we could see no way of getting a clue in regard to the purposefulness of each act or to the newness or vividness of the stimuli which set oft each adjustment

Subjects. Our S's were 46 nursery-school children. The age range in the group at the beginning of the investigation was from 21 to 58 months; and the number of boys and girls was, respectively, 21 and 25 These S's were probably generally more than normally well adjusted and also above the average in both physical and socio-economic status They came mainly from homes where the wage earner belongs to the professional or business-executive class. Hence, as far as some of the issues in our problem are concerned, the group may be considered rather homogeneous. Such a state of affairs would tend to favor low correlations

Being naive and accustomed to having many persons around, the children gave the observer little heed The observation period at any one time being brief, moreover, our S's would be unlikely to realize that they were the objects of our attention. This fact buttresses our opinion that the behavior samples we have are not colored strongly by self-consciousness stimulated by the experimenter.

Procedure. We received our inspiration with respect to observation method largely from Olson's (7) work. Questioning, however, his procedure of taking time samples in immediate succession and of giving each sample an all-or-none score, we chose to observe our S's during 400 half-minute units, only one minute, with some exceptions, being the length of the sample obtained for a single day. Our observations extended, consequently, over the best part of eight months—a fact which would emphasize in our returns the relationships existing between the more stable influences and would tend to reduce the size of many of our correlations. Deviations from the procedure of gathering daily one-minute samples were necessary because of the exigencies that invariably arise when one is working with young human subjects

Scoring The S's score for any one movement mannerism was the number of times the pattern was executed during 400 observation periods. The two half-minute observation units taken on a single day were separated widely in time, and the order of focusing upon the subjects systematically rotated, as far as that was possible. The observations were distributed, moreover, so as to yield 100 half-minute samples of behavior for each of the following activities. free play indoors, free play outdoors, directed play or circle work indoors, and routines, such as washing the hands and taking off or putting on wraps.

Observers. Two O's underwent a six-weeks period of training for their task. Since flat disagreements after training were rather few, when the more skillful of the two O's was able to record 85 to 100 per cent of the happenings both observed, then one O was given the sole responsibility for making the records This O was Miss Helen Streit, and of her skill and devotion we would make acknowledgment here.

RESULTS

Reliability of Measures. The reliability of our measures we attempted to test by correlating the scores made during odd- and even-numbered observation periods. These coefficients are given in Table 1. Some confidence in the measures seems warranted; for when the Spearman-Brown corrections have been applied, +.77 is the magnitude of the lowest reliability coefficient and + 98 the highest Eight of the 11 are + 83 or above [2]

Stability of Measures What is probably more significant is the fact that the correlations between measures based on the performance of the children during the first and last half of the year are in some cases of considerable size (See Table 1.) The coefficients range from + 30 to +.91, 9 of the 11 being + 49 or greater. These results, in view of the general homogeneity of the group and the fact that the children were growing rapidly, suggest that we are dealing, in the main, with rather stable behavior casts and are justified in applying the designation, "movement mannerism," to at least most of the phenomena being investigated

Sex Differences Our understanding of these mannerisms will probably be most effectively furthered if we consider first their relation to some of the variables mentioned earlier Believing that physical structure—long or unruly hair, for example—might have an effect upon mannerism frequency, we asked ourselves whether the sexes differed; and if they did, whether the differences were limited to certain patterns or appeared in all. We grant, of course, that the dissimilarities that exist between the two sexes may not be functions of obvious structural disparities. A study of the sex-group

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[2] We wish to acknowledge the generous assistance given in the statistical work of the study by Mr William J C. Koch and Mr William Langenbach

TABLE 1

Reliability Coefficients (Alternate Observations) and Correlations Between Scores Based on the First and Second Halves of the Behavior Sample

Behavior pattern	Reliability coefficients (alternate observation, Spearman-Brown correction)	Correlations between scores based on first and second halves of the behavior sample
Genital	+ 842	+.300
Pedal	898	528
Ocular	771	569
Caputal-hirsutal	834	.330
Corporal-mass	864	.689
Oral	.953	.723
Nasal	853	624
Aural	982	913
Digital	788	490
Corporal-limited	846	.524
Respiratory	787	.569
Physical attack	853	606
Verbal attack	863	690
Remote attack	545	376
Refuse and ignore	797	485
Ignore request	743	.635
Non-participation in formal group work	.863	629
Talk about self	908	770
Make much noise	878	572
Act silly, grimace, swagger	872	492
Cry, scream, whine	.837	600
Flit	525	210
Pout, sulk	847	482
Play alone	737	611
Day dream	662	476
Watch others	927	793
Do as others do	811	539
Comply with requests	715	495

averages (see Table 2) reveals that the boys tended significantly more strongly toward masturbatory activities than did the girls, while the latter exceeded the former in scalp or hair manipulation These findings are in line with our theory that local irritations and peripheral structural differences may be pivots on which much turns. It is significant, on the other hand, since there are no obvious digital differences between the sexes, that finger play is found more fre-

TABLE 2
SEX DIFFERENCES IN MEAN NUMBER OF MANNERISMS FOR AN INDIVIDUAL

Mannerism	Boy Mean	Boy σ dist	Girl Mean	Girl σ dist	Critical ratio
Genital	2.31	3.35	.78	.45	+2.07
Pedal	2.98	3.74	3.02	3.60	—.04
Ocular	4.07	4.90	3.42	1.90	+.54
Hirsutal-caputal	1.79	1.28	8.62	5.60	—5.64
Corporal-mass	114.90	25.45	113.90	23.40	+.14
Oral	104.65	32.85	101.50	41.20	+.29
Nasal	8.02	4.95	9.86	8.04	—.95
Aural	1.60	1.06	3.42	7.93	—1.13
Digital	57.25	14.75	65.10	16.75	—1.69
Corporal-limited	29.00	14.96	27.88	12.34	+.27
Respiratory	1.83	2.12	1.22	1.15	+1.22

quently among girls. Perhaps the more sedentary pursuits or greater inhibition of the latter are responsible for the finding, or even a greater tendency toward the neurotic disposition which clinicians are wont to emphasize when discussing the etiology of "nervous habits." At this stage choice between these hypotheses is unwarranted.

Situation. It has been alleged that restraint favors mannerisms. On this allegation we hoped to shed light by observing the children in types of situations which varied partly in the amount of freedom they permitted.

We obtained 100 half-minute samples of the behavior of each child during each of the following kinds of activities: free play indoors, free play outdoors, controlled play indoors, and routines, such as washing, dressing, and undressing. This classification we thought would throw into relief, in addition to other effects, those due to differences in degree of freedom. The average number of each of the movement mannerisms shown by a child during each of the activities is presented in Table 3, where are given also various measures of dispersion.

Only in the case of scalp and hair manipulation and sniffing did the mannerisms occur less frequently in indoor controlled play than in the other activities. The indoor controlled play is, undoubtedly, the most restraining, as it frequently entails sitting quietly in more or less crowded quarters, and listening, as well as following directions. Such a finding is in keeping with the belief that stimuli set up impulses which must find a motor outlet; and if they cannot

TABLE 3

Mean Number of Mannerisms for Various Types of Activity and Critical Ratios for Comparisons Possible

Classes of mannerisms	Means				Critical ratios					
	Free play indoors	Free play outdoors	Routines	Controlled play indoors	Free play indoors vs free play outdoors	Free play indoors vs routines	Free play indoors vs controlled play indoors	Free play outdoors vs routines	Free play outdoors vs. controlled play indoors	Routines vs. controlled play indoors
Genital	63	54	57	1.24	+4.50	+3.00	—1.91	—1.50	— 2.19	— 2.09
Pedal	1.08	1.00	1.22	1.22	+ 40	— .50	— 44	— 79	— .69	00
Ocular	91	1.39	1.26	1.65	—1.71	—2.50	—3.70	+ .41	— .74	— 1.56
Caputal-hirsutal	2.20	1.02	2.28	1.61	+2.95	— 17	+1.40	—3.82	— 2.11	+ 1.86
Corporal-mass	28.96	20.40	17.74	47.04	+4.63	+6.06	—7.23	+1.80	—11.84	—13.02
Oral	26.04	25.66	21.18	30.96	+ 16	+2.41	—2.27	+2.05	— 2.28	— 4.89
Nasal	2.91	1.17	2.54	3.67	+4.83	+ 80	—1.15	—3.91	— 4.31	— 1.74
Aural	1.20	70	1.00	1.20	+1.39	+ 57	00	—1.36	— 1.22	— 50
Digital	14.63	10.70	9.57	27.72	+2.98	+3.98	—7.57	+1.00	—10.44	—11.42
Corporal-limited	6.20	1.91	4.39	17.02	+7.27	+2.66	—7.26	—5.39	—10.72	— 8.71
Respiratory	.74	91	74	61	—1.00	00	+1.30	+ 85	+ 2.14	+ 1.30

effect this in purposeful acts involving the body grossly, they will do so in more or less irrelevant activity. It is even probable that offenses against the ego which occasion emotional upsets occur more often in controlled play than in the other activities And lastly, the hypothesis is also tenable that attention is less dynamically held by the games dictated by the teacher and thus is focused more readily upon minor body irritations. These three concepts are very different. Since they are not mutually exclusive, all may apply.

Of the exceptions to the general trend described in the preceding paragraph it is not difficult to give a reasonable interpretation. The greater range of temperature stimulations out-of-doors than indoors doubtless arouses to a greater degree the secretory mechanisms of the nasal mucosa. The sniff, especially in young children, is a means of adjusting to a serous or mucous flow, as handkerchiefs are none too popular. That head and hair manipulation should also have been greater out-of-doors than indoors may have been due to the disarranging of the hair by the wind or the greater strenuousness of the outdoor play.

The comparison of free play indoors and out is another one which should expose the effect of inhibition, both physical and social To assume that the differences between the two activities lie largely in the measure of restraint imposed by the physical environment rather than the social is probably not correct, for effort must necessarily be directed toward the protection of the nursery building when the children are indoors This would result in more interference from adults There would, moreover, be more crowding indoors—a condition with social ramifications

At any rate, we note, as we expected, fewer mannerisms in the outdoor free play than in the indoor, with the exception of the respiratory and ocular. In the case of the exceptions the critical ratios are not large Ocular stimulation, like the nasal, may be somewhat greater out-of-doors, because of the more extensive range there of light and temperature variables as well as the greater likelihood of getting irritating substances into the eyes. Throwing dirt and sand is a favorite occupation of preschoolers

The average number of mannerisms observed for a child during the free play activities indoors is probably reliably greater than that observed during routine activities in the case of the categories labelled corporal-mass, oral, digital, genital, and corporal-limited—a finding that, in the light of any theory of etiology expressed in terms of social interference, would seem queer The toll for the former type of situation with respect to eye adjustments is, however, conspicuously less than the latter. These findings are congruent with the hypothesis previously set forth; i e, that some of the phenomena under consideration are associated with passivity. Carrying through routines usually involves well-directed purposeful body activity of a gross, and in the main not unpleasant, sort and hence is likely to exercise a more powerful control of attention than does free play indoors. That the eye adjustments should show a trend contrary to the other mannerisms may again be due to specific situational features—the danger, for example, in washing and dressing, of getting something in the eyes. It is interesting, in connection with our attention and extent of body involvement theories, that during routines, in contrast with free play outdoors where activities tend to be the most vigorous, dynamic and objectively directed, significantly more head, body, and nose mannerisms were disclosed, but fewer of the oral. The oral adjustments may fail to conform because of their more clearly recognized satisfaction-producing character. Where choice of activity is allowed, as it is in free play, oral pleasures may be sought.

Numerous other specific comparisons we might make, but it seems clear that type of activity, with all that that involves in the way of restraint, mind set, unique stimulations, and grossness of adjustments permitted, has a significant effect upon the frequency with which certain movement mannerisms are displayed. This finding has a bearing, among other problems, on the one of behavior sampling. Mannerisms generally occur with greater frequency in indoor play than outdoor, and in controlled play than in free. Whether the effect of the situation varies also from individual to individual it did not seem feasible to attempt to determine with our data, for in the case of some of the categories the scatter of the measures was too small to justify any correlations

Parental Attitudes To assess the hypothesis that irritability of parents favors the development of "nervous habits" in children—though we grant that any association of irritability in parents and mannerisms in their children may be mediated by genetic mechanisms

TABLE 4

CORRELATIONS BETWEEN MOVEMENT MANNERISM SCORES AND VARIOUS MEASURES OF HOME CONDITIONS AND PARENTAL ATTITUDES

Mannerism	Annoyance test score—mother	Annoyance test score—father	Number of sibs	Number of playmates	Number in household	Number for a room in house	Number of residences since birth
Genital (boys)	—096	+147	—041	—136	—170	+208	—146
Genital (total)	—125	+155	—060	—023	—126	+073	—112
Pedal	—016	—289	—032	+317	+031	+043	—027
Ocular	+040	+044	+181	+259	+192	—236	—072
Caputal-hirsutal (girls)	+548	+481	—069	+439	—165	+102	—294
Caputal-hirsutal (total)	+312	+012	+027	+199	—082	+127	—203
Corporal-mass	+030	—013	—203	+164	—037	+018	—022
Oral	+235	+009	—038	+313	—164	—107	—093
Nasal	+034	+177	—140	+120	+042	+212	—025
Aural	—131	—054	+005	—106	+111	+337	—125
Digital (boys)	—065	+114	+069	+187	+085	—273	+169
Digital (girls)	+308	+321	—324	—406	—260	—252	+232
Digital (total)	+090	+147	—147	—129	—099	—220	+161
Corporal-limited	+008	—263	—142	+316	—221	+046	—073
Respiratory	+118	+054	—057	+078	—132	—152	+082
Total mannerisms (boys)	+137	—101	—074	+448	—124	+100	—102
Total mannerisms (girls)	+237	+469	—316	+350	—175	—287	—039
Total mannerisms (total)	+193	—009	—177	+364	—142	—053	—083

instead of tutorial or interpersonal—we correlated the scores made by the parents of our subjects on the Cason Inventory of Common Annoyances with the children's rankings on the basis of the various mannerism counts (see Table 4). Since only 23 of the fathers and 26 of the mothers filled out the Inventory, the danger of large sampling errors in our data must not be overlooked What the Inventory actually measures, moreover, is a question of significance Elsewhere (6) we have indicated our belief that it describes more effectively conscientiousness or loyalty to our social forms than it does the kind of explosiveness some have in mind when they think of irritability. At any rate, whatever the parents' reports of themselves gauge, this seems relatively unrelated to the mannerisms observed, except in the case of the girls The more annoyed or conscientious mothers tended to have the daughters who "fussed" most with their head and hair, and played most with their fingers. These relationships we might have anticipated

Attending to the categories treated separately for the sexes,[3] we observe that there is a more marked relation between the parent's annoyance score and the mannerism count for the offspring if they are girls than if they are boys. We note also that, slight though it is, there is a somewhat more consistent tendency toward a positive relationship than negative in all of our data—a trend which would lend some support to the theories stated earlier.

Home Conditions. Among the home conditions investigated in relationship to mannerism frequency were number of sibs, number in the household, number of occupants for a room in the house, and number of residences the child had occupied since birth. (See Table 4.) Such an inquiry, it was thought, might shed light on the effect of crowding, competition, extent of social experience, and instability of residence with its attendant possibility of social insecurity.

Not surprisingly, because of the multidimensionality of the variables of concern to us, none of them correlated to any very marked degree with the mannerism counts. The item, number of playmates, yielded usually a positive coefficient and several that were over +.30. With the sign of the coefficients the reverse of that which the theory of social inexperience would lead us to expect, we were stimulated to surmise that age was the variable largely responsible for the picture we saw. Partialing out age, however, altered the correlations very little, even increasing several We are, hence, inclined to lend credence to the view that a large number of playmates may result in much competition and strain which in turn may provoke mannerisms or excess movements

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[3] Only in the case of the categories in which the sexes seem to differ significantly have correlations been computed for each of the sexes separately When, moreover, the reliability coefficients indicate that for a given sex group any measure is grossly unreliable, we have thought it valueless to present any coefficients involving the undependable index This will be our policy throughout the report

In contrast to what obtains in the case of playmates, the more sibs and the more persons there are in the household, the fewer tend to be the mannerisms, it seems. The tendency is reasonably consistent, though the individual correlations are small. If they have any significance, we confess we find it difficult to harmonize the findings relative to sibs and playmates.

Constipation Index To probe further into the theory that emotional tension favors automatisms, we attempted to discover whether mannerism frequency and constipation are related, the latter being suggested often as a consequence of inner disturbances of more than the normal order Cannon, for instance, maintains that fear and anger tend to reduce gastro-intestinal motility We devised a constipation index based on the parents' report (1) of the general consistency of the child's stools, (2) the frequency of the latter's bowel movements, and (3) the frequency with which laxatives were used as well as attention given to a laxative diet. The index is crude It is, in the first place, founded on the parents' report, which, in turn, is based upon impression rather than upon a day-by-day record. We could, however, see little motivation for falsifying the report; and the data called for seemed simple enough and sufficiently well known to cause the account rendered to be reasonably accurate. We took the parents' check lists and gave each checking a numerical value, a four-point rating scale being used for each of the items, frequency and consistency of the stools, and frequency of the use of laxatives. These ratings were given equal weight and merely summed, thus resulting in a final index whose possible range was from 0 to 12. This measure, crude though it is, yields with few exceptions positive correlations with the mannerism scores (see Table 5), only the coefficients involving the total score for the boy's group and the oral

TABLE 5

CORRELATIONS BETWEEN MOVEMENT MANNERISM SCORES AND MEASURES OF INTELLIGENCE, CONSTIPATION, AND CERTAIN SKIN RESISTANCE PHENOMENA

Mannerism	I.Q	Constipation index	Absolute skin resistance level—Series I	Absolute skin resistance level—Series II	Relative decrease in skin resistance	Relative recovery in skin resistance	Age
Genital (boys)	+ 245	— 036	—.062	+.049	— 177	+.242	— 110
Genital (total)	+ 143	— 032	+ 093	+ 060	—.078	+ 056	— 035
Pedal	+ 077	+ 285	— 025	— 001	— 009	+ 045	+ 383
Ocular	+ 271	+ 001	+ 006	— 151	+.052	—.162	— 254
Caputal-hirsutal (girls)	+ 328	— 132	— 250	— 153	— 077	+ 037	— 131
Caputal-hirsutal (total)	+ 183	+ 039	— 299	— 091	+ 039	+ 095	— 119
Corporal-mass	+ 022	+.205	+ 056	— 156	+ 168	+ 090	+ 108
Oral	— 174	+ 393	— 047	+ 160	+ 215	+ 060	—.146
Nasal	— 064	+ 182	— 058	+ 241	+ 187	+ 094	+ 009
Aural	+.053	+ 125	— 102	— 025	— 105	+ 312	— 149
Digital (boys)	+ 229	+ 154	+ 119	+ 171	+ 109	— 188	+ 121
Digital (girls)	+ 051	+ 150	— 008	— 060	— 389	+ 054	— 019
Digital (total)	+ 145	+ 167	— 006	+ 011	— 156	— 008	+ 004
Corporal-limited	— 056	+ 215	+ 098	+ 227	+ 084	— 309	+ 043
Respiratory	— 022	+ 107	+ 149	—.122	— 273	— 224	+ 062
Total mannerisms (boys)	— 010	+.611	— 032	— 005	+ 216	+ 066	— 095
Total mannerisms (girls)	— 131	— 016	+ 060	+ 164	+ 119	+ 056	+ 054
Total mannerisms (total)	— 053	+ 475	— 037	+ 077	+ 183	+ 070	—.024

manipulation score (total group) being large enough, however, to be taken seriously. The data, then, while they present no unassailable proof of the doctrine that mannerisms are end products of such internal commotion as would interfere with gastro-intestinal motility, are at least not at odds with the theory. Nor are they out of line with the hypothesis that passivity, which favors mannerisms, is also a condition favorable to the development of constipation

Skin Resistance Phenomena. To uncover if possible the relationship between our mannerism data and certain visceral patterns other than those reflected in constipation, we arranged to observe various skin resistance phenomena for each child in our group under a standard set of stimuli. (See Table 5.)

The children were brought to the laboratory by the same attendant, an individual whom they all knew well Their shoes and stockings were removed and their feet brushed with alcohol Then for approximately 10 minutes the attendant read them certain stories, thus allowing for some recovery from the activity in which the child was engaged before coming to the laboratory.

Electrodes of the type described by Darrow[1] were employed. One was fitted to the sole of one foot and the other below the knee on the back of the corresponding leg Placing the children in a high chair with a specially devised foot rest enabled us to minimize movements during the test In order, however, to have a record of this variable, one O, using a code, described thereby movement in any one of the grosser anatomical parts. She also obtained a record of the temperature, humidity, barometric pressure, as well as the child's temperature

Two similar series of 15 stimuli were administered, the series being separated in time anywhere from a week to a month. Irregularities in the interval were due to illness of the children, dropping out of school, the termination of the session, etc. For most of the S's, however, the series were separated by about 4 weeks. The O who brought the children to the laboratory and read stories to them, preliminary to the record taking, gave the stimuli, while another O managed the apparatus which was not in the room that housed the child.

The stimuli consisted of showing the child himself in mirrors of two sizes, sounding a klaxon or whistle on 3 different occasions, blowing a spray of cold water or placing a cube of ice briefly against the back of the neck, showing a candy rabbit or some cookies but withholding them, showing an auto, or a ball attached to an elastic, and promising these as rewards at the end of the experiment, presenting some perfume or a perfumed flower to be smelled, threatening to tip or push the chair over, praising or kissing the child, tickling the lips or soles of the feet, brushing a plate or a hand before the eyes, threatening with a rubber band or small gun, announcing the end of the performance. Among the stimuli we planned to include about an equal number of pleasant and unpleasant, though, of course, what is pleasant or unpleasant depends upon the mind set of the individual—something not within our control directly. The method of exposing the stimuli and their timing were standardized as far as possible, as were also the comments made. The stimuli were presented at the rate of one every half minute, except when deviations from this schedule, it seemed, would save the major values.

The child's general reactivity was estimated by averaging his standard scores for each of the 30 stimuli Skin resistance decrease was measured in terms of the distance, described in 1000-ohm units, from the base to the peak of the curve resulting from stimulation. The 1000-ohm scale was registered on the film at the beginning and end of each session. Relative recovery was defined as the ratio of the recovery in ohms during the three-second period after the peak of the curve had been reached and the total resistance decrease caused by the stimulus Our procedures are patterned after those of Darrow (2, 3, 4, 5).

To give a picture of resistance level, the level of the resistance before each stimulus was noted. These were averaged separately for Series I and II.

There were many variables we feel we could not control adequately The temperature of the room could not be kept entirely constant, and this variable, we have discovered, correlates with extent of change in skin resistance. Some of the children, moreover, moved in spite of our efforts In these cases we compromised with our intention of keeping the interval between stimuli constant and waited until the child was quiet before we exposed him to the next stimulus. Even then he sometimes moved before the reaction was completed. Occasionally we had to talk to a child, our silence in the face of persistent queries causing more difficulty than a brief noncommittal comment. The children, furthermore, came to the laboratory with different degree of apprehensiveness, some being more familiar with our quarters than others, though all had had some pleasant contact with them before the experiment was begun. The sampling of stimuli may not have been extensive enough. Preliminary to the session the children were not doing the same thing Whether the ten-minute rest period we used was sufficient to permit recovery from the effect of previous activities we are not sure, but a longer interval introduced the problem of keeping the child quiet While this is a formidable list of difficulties, most of them did not obtain in the case of a fair proportion of our subjects We never failed to be surprised at the degree to which the youngsters accepted the experimental situation and did what they were told to do By reciting our difficulties, however, we hope to avoid giving the impression that negative results prove there are no relationships of significance to be revealed by our general method if controls could be made more satisfactory Any association we may uncover will, then, have to show above these variables and hence, we believe, will have to be of considerable size.

In the case of the boys virtually nothing of interest is noted in the correlations between our skin resistance measures and the items, genital and digital Focusing on the girls, we note what seems to be a dependable negative correlation between relative decrease in skin resistance and finger play This result is congruent with the theory that ascendance is positively associated with relatively large resistance changes, if we are correct in our interpretation of evidence which has seemed to indicate an association of the more introverted trend in behavior with a tendency to indulge in finger play.

In the categories where it appeared safe to use the whole group for deriving the correlations, we discovered nothing of significance with respect to resistance decrease except, perhaps, a negative association with respiratory mannerisms. With the measure of relative recovery a tendency toward ear play seems positively correlated, whereas the count descriptive of the tendency to stroke the body is negatively related In the main, these data on skin resistance characteristics yield little that is startling; but such associations as seem worthy of comment are at least not out of line with the findings of other workers

IQ. Correlating the mannerism counts with IQ, as determined by the Kuhlmann-Binet test, we obtained, likewise, few coefficients of any size. Those involving ocular and hirsutal (girls) adjustments are probably indicative of a dependable positive relationship (see Table 5).

Social Behavior Patterns We most frequently hear mannerisms referred to as indexes of nervousness, the latter term being used in a rather nebulous fashion; but the inference ordinarily contained in the statement is that nervousness is an emotional state resulting largely from conflict. One would expect, in accordance with this hypothesis, to find an individual who is a misfit in his social environment running up a large toll of mannerisms.

In the face of these assertions we thought it well to attempt to discover whether mannerisms in our group were associated with patterns of behavior suggestive of struggle and conflict, of escape, of attack attitudes, of inhibition, and of aggression. Since we wished our measures to be based on frequency counts of significant behavior patterns, we were faced with the problem of selecting from patterns which observers tended to interpret similarly some that would at least reflect what we were interested in How well we have succeeded in our selection is a question

The O who gathered the data on mannerisms collected them also for these other patterns. The same O-training and time-sampling procedures were employed as in the case of the mannerisms, as well as the same distribution and number of behavior samples

A few of the categories listed in Table 6 may need further description. Under vigorous physical attack we included pushing, pulling, pulling hair, striking, biting, pinching, kicking, tripping, holding, blocking, and snatching another's possessions directly from him. In the grouping labelled "verbal attack" we placed swearing, criticizing, calling names, passing derogatory remarks, ostracising another from the group, contradicting, threatening, gloating, being insolent, expressing doubt of another's convictions, teasing, bullying, tattling, and asserting ownership to ward off competitors. Only if comment was involved was the activity placed under "verbal attack." Under "indirect attack" was subsumed inconveniencing an opponent in ways not involving direct physical or verbal assault—i e., protecting a possession by reaching for it or covering it before others had a chance

Measures of social behavior	Genital (boys)	Genital (total)	Pedal	Ocular	Caputal-hirsutal (girls)	Caputal-hirsutal (total)	Corporal-mass	Oral	Nasal
Physical attack	+.238	+319	—186	—108	+214	—.281	—155	—091	—091
Verbal attack	+051	+118	+164	—043	—213	—317	+194	—210	—052
Indirect attack (boys)	+116		—075	—046			—019	—081	+185
Indirect attack (girls)			000	+566	+152		—162	+140	—.128
Indirect attack (total)		+148	—038	+145		—099	—093	+049	—049
Refuse and ignore	—083	—005	—277	—069	+246	+073	—145	+009	—015
Make much noise (boys)	+198		+362	—184			—193	—050	+148
Make much noise (girls)			—076	+379	+191		+233	—192	—029
Make much noise (total)		+313	—131	—004		—305	—015	—073	—030
Act silly, grimace, swagger	+626	+634	—196	+022	—192	—.302	—007	+.013	+070
Talk about self (boys)	+114		—224	—060			—189	—291	—142
Talk about self (girls)			+174	+196	+188		+300	—161	+063
Talk about self (total)		+196	—018	+044		—173	+065	—184	—065
Try to boss	—203	—067	+096	—055	+046	—100	+.017	—165	—086
Non-participation in formal group work	+056	+009	—141	—061	—111	—063	—.268	—085	—206
Smile or laugh	+120	+183	—118	—094	+153	—123	+078	—096	+.240
Cry, scream, or whine	+091	+054	—327	—071	+686	+485	—139	+147	—066
Conform, do as others do	—142	—113	+257	+125	+167	+141	+151	+001	—081
Comply with requests	+042	+127	+133	—579	+314	—103	+107	+005	+119
Play alone	+312	+206	—.237	+017	—284	—.121	—196	—008	—168
Day-dream, stare vacantly	—134	—090	—053	+366	—201	—101	—067	—146	—076
Pout or sulk	—.275	—198	+036	+037	+052	+073	+188	+111	—102
Watch others (boys)	—137		+539	+003			+329	+258	+008
Watch others (girls			—193	—092	+122		—486	—247	—142
Watch others (total)		—252	+102	—061		+427	—148	—084	—021
Flit	+.390	+432	+019	—115	—017	—115	—098	+158	+077

TABLE 6 (*Continued*)

Measures of social behavior	Aural	Digital (boys)	Digital (girls)	Digital (total)	Corporal-limited	Respiratory	Total mannerisms (boys)	Total mannerisms (girls)	Total mannerisms (total)
Physical attack	—.214	—541	—.260	—468	—133	—169	—293	—.368	—336
Verbal attack	—084	—021	—269	—.222	—143	—.067	—.240	—054	—189
Indirect attack (boys)	—246	—347			—202	—.250	—.167		
Indirect attack (girls)	—098		—.295		—.198	—213		—.109	
Indirect attack (*total*)	—.125			—351	—182	—.172			—165
Refuse and ignore	+082	+100	—211	—.126	—116	+.153	+215	—363	—115
Make much noise (boys)	—086	—599			—028	—273	—252		
Make much noise (girls)	—130		—259		—024	+114		—.124	
Make much noise (total)	—.148			—.475	+001	—043			—228
Act silly, grimace, swagger	+108	—309	—.253	—.298	—114	—012	—101	+026	—095
Talk about self (boys)	—092	+019			—201	—105	—.279		
Talk about self (girls)	+313		—383		+136	+078		+.016	
Talk about self (total)	+146			—.282	—014	+041			—174
Try to boss	+004	—050	—432	—.298	—102	+059	—358	—004	—221
Non-participation in formal group work	—039	—104	+052	—010	—189	+027	+053	—510	—242
Smile or laugh	+084	—150	—220	—.223	+015	—098	—125	+.093	—082
Cry, scream, or whine	—128	+.273	—101	+052	—042	+160	+.179	—.070	+048
Conform, do as others do	—148	—.013	—.248	—.111	—067	—132	—206	+.215	+011
Comply with requests	—130	—.299	—.060	—244	+043	+047	—.075	+099	—040
Play alone	+167	—175	—.248	—196	+.043	—073	—301	—040	—.151
Day-dream, stare vacantly	+183	+044	+.202	+087	—036	+206	—216	+.211	—075
Pout or sulk	—.001	+.352	+.299	+.319	—148	—072	+.263	+.113	+186
Watch others (boys)	+363	+306			+293	+017	+409		
Watch others (girls)	—143		+.531		—334	+120		—372	
Watch others (total)	—003			+487	—.071	—.044			+043
Flirt	+073	—509	—189	—.394	—.098	—.231	—082	+038	—065

to claim it, pursuing another but not attacking, destroying a possession when its owner was absent, and snatching an object when its possessor had his back turned

With the concept "flitting" we had considerable difficulty, in part because of the problem of delimiting activities We considered an activity terminated when the child left the locus of one task and gave no evidence of a purposeful relation between his new activity and the one he left This is somewhat subjective, and the relatively low reliability of our measure (Table 1) is probably a reflection of this fact We classified a child's behavior as flitting if he shifted his interest to three or more different things or materials in one half minute Since this is, of course, entirely arbitrary, one must keep in mind that other procedures might yield different results.

In attempting to distinguish between watching and day-dreaming, we were challenged to an even more marked degree by the problem of defining in such a way that observers could agree in their classifications. When a child was looking directly at others and following their activities this was classified as watching, but when he seemed to be staring vacantly into space, we called that day-dreaming It would probably be safer to designate the latter category "staring." Whatever it signifies, and in spite of the difficulty the judges had with it, it does have some stability (see Table 1).

The reliability coefficients for the behavior indexes listed in Table 1 range from +.53 to + 93, most of them being above +.70. The correlations between the first and second halves of the data, moreover, intimate that there is considerable stability in many of the traits described

Passivity, Inhibition, Conflict The tendency to play alone seems positively related to a tendency to masturbate, negatively to a proneness to play with the fingers, and, in the case of the girls, negatively with our measure of hair and scalp handling (Table 6)

The second relationship seemed surprising at first, because of our inclination to think of those who play alone as being relatively inactive—as idling or as at odds with the group. This is not necessarily the case, especially with young children, many of whom are most completely absorbed in a task when they are playing alone. Under the condition of absorption, particularly if it parallels gross body movement, there would be little occasion for finger play or even hair adjustments Masturbation, in contrast to finger manipulation, may be viewed as a form of asocial play

It is not to be overlooked in this connection that a proneness toward watching others, an activity which does involve considerable passivity at least, if not conflict, is positively associated with a tendency to finger manipulation, while being negatively associated, if anything, with an inclination to masturbate The latter relationship does not square with the frequently iterated assertion that the child on the outskirts of a group tends to seek satisfaction in autoerotic practices. The fact, however, that those children who spend much time watching others are not inclined to masturbate may be explicable again in terms of the age of our S's. In the case of the very young, watching, while a relatively quiet activity, is a sign of social interest and not necessarily of conflict or social failure In the light of this consideration, and of data we shall describe presently, it seems probable that a tendency to masturbate, as we had opportunity to determine it, is linked with social ascendance.

More clearly indicative of internal conflict than any of the measures discussed so far is that descriptive of a tendency to pout and sulk. It is notable that this correlates positively and probably to a significant degree with a disposition to indulge in finger play We observe with respect to our measure of masturbation tendencies, however, a negative relation, if any (see Table 6).

Our assessment of the children's inclinations to stare or day-dream shows no relationship worth commenting upon to the mannerism counts, except a negative one with the measure of the frequency with which the eyes are blinked vigorously or rubbed Perhaps an extra exertion was necessary to counteract the strain caused by the sustained ocular postures (see Table 6)

Aggression and Attack In contrast with the trends shown in the case of pouting and sulking—attack which is not overt—we find that the correlations between our mannerism scores and measures which are not only suggestive of aggressiveness but also in most cases of conflict are largely negative Hair play among the girls is an exception.

Most of the coefficients in Table 6 are not large, but the trend just mentioned is consistent The indexes which we suspect of bespeaking to a greater or less degree an aggressive tenor are those describing a tendency to attack physically, verbally, or remotely, to refuse or ignore, to fail to conform to the group pattern to the extent of refraining from engaging in the formal circle work; to boss; to talk about one's self, to make much noise, to grimace, act silly, or swagger; to do something other than what was requested without overtly refusing, to flit; and even to laugh and smile. The measure of finger play yields uniformly a relatively larger negative r with these indexes than do the other mannerism counts

The positive correlation between our gauge of proneness to masturbation among boys and the indexes describing aggressive leanings is again due some comment. Since we were not able to observe the children in the pre-sleep period, those who are reported as masturbating did it rather openly. Indulgence in the practice, in spite of the fact that society legislates so vigorously against it, is in itself evidence, we think, of a tendency to unsubmissiveness

Compliance and Conformity Additional light on the place of aggression and dynamicness in the gestalt we are trying to understand may be shed by a few other correlations involving the traits cooperation and conformity, which, from an *a priori* view at least, cut across the aggression-inhibition axis rather than proceed in the same direction to the degree of those trends mentioned in the foregoing discussion.

The correlations between our mannerism counts and compliant behavior measured in terms of the frequency of the child's accession to requests made of him, for example, are not so uniformly negative as are those between the former and measures indicative of attack attitudes We do observe, however, negative coefficients in the case of eye adjustments and also finger play Perhaps the uncompliant cannot squarely face those making requests and hence indulge in such ocular evasions as blinking or vigorously rubbing the eyes We should, moreover, expect the compliant to be kept so busy as to have little time for finger play That the more compliant among the girls should tend to handle their hair more than do the less compliant we might also have anticipated, as a habit of adjusting the hair may reflect another form of compliance—i e , a desire to conform to certain standards in personal appearance

Those children who tended to be found doing what the group was doing—the conformists, in other words—like the compliant—those seen acceding to overt requests—showed less of a tendency to rank relatively low in mannerisms than did the clearly aggressive. Some of the positive r's which appear in Table 6 we suspect are attributable to the factor of age, the case of pedal mannerisms especially being one in point

Expressiveness Tendencies to smile, laugh, cry, or whine might have been thought of as mannerisms and treated as were our other categories. We chose somewhat arbitrarily, however, to deal with them largely as indicators of the readiness with which the child reveals his pleasure or displeasure The proneness to crying or whining seems negatively related to a disposition to stand on the sides of the feet—a fact we again think attributable, at least in part, to the operation of a maturity factor. The only other r of any size is that of +.686 in the case of the head manipulation count for girls. Perhaps the tendency to adjust the hair continually is an index of self-consciousness and sensitiveness—an attitude which at this age might betray itself also in many vocal expressions of dissatisfaction.

Since little consistency is shown among the correlations involving the measure of smiling, whining, etc., we feel we have no evidence which supports the theory that those who do not readily express their feelings in the primitive vocal-facial gestures tend to run up higher tolls in nervous habits

Inter-index Correlations. Our data so far lend support to the view that the influences are many which contribute to the appearance of the movement patterns we have been studying An influence, moreover, may favor one type of pattern and not another Passivity, inhibition, lack of overt attack tendencies, internal conflict, restraint, local irritation, specific structural features, and boredom have been suggested as significant.

To define further the relationship between our various measures we shall present the inter-index correlations separately for the boys and girls, with and without age partialed out Since the reliabilities of the measures used are reasonably high, the inter-item coefficients cannot be very attenuated and hence we did not correct for this factor

In the case of the boys 11 of the 36 coefficients are greater than +.35, all but one of the 11—that between finger play and genital handling—being positive In fact, 24 of the 36 r's in Table 7 are positive. The picture for the girls bears little resemblance to this.

TABLE 7

INTER-INDEX CORRELATIONS WITH AND WITHOUT AGE PARTIALED OUT*—BOYS

	Genital	Pedal	Ocular	Corporal-mass	Oral	Nasal	Digital	Corporal-limited	Respiratory
Genital		+019	—017	—.243	+286	—049	—460	—070	—118
Pedal	+051		—.252	+385	+420	+.283	+217	+173	+.052
Ocular	+009	—336		—210	+.104	—089	—036	—047	—055
Corporal-mass	—262	+444	—184		+544	+423	+428	+035	+122
Oral	+277	+470	+135	+537		+494	+045	+.351	+122
Nasal	—037	+264	—119	+446	+513		+.084	+066	+.002
Digital	—453	+192	—066	+453	+060	+072		+386	+469
Corporal-limited	—100	+256	+011	+001	+335	+097	+432		+516
Respiratory	—144	+111	—009	+097	+102	+025	+.507	+492	

*The raw correlations are above the diagonal; those with age partialed out are below. This scheme will be followed throughout the paper

Only 4 of the coefficients are above +.35, 3 of these being plus. Only 13 of the 36 correlations are positive (see Table 8) Of the 4 largest coefficients only one describes a relationship also found to be of significant size in the case of the boys.

These findings, then, like our others, lend no substantial support to the theory that the response patterns we are studying are mainly the expression of a single factor Either we have given attention to the wrong manifestations, masked the essentials by our procedure, worked with groups that are too small, or the factor of nervousness, if it exists, expresses itself in more limited ways than is usually implied Our multiple factor analysis will, we believe, throw more light on the problem of basic contributing influences

Inter-index Correlations for the Group of Boys. In Table 7 measures of mouth, finger, and body handling claim the larger correlation coefficients, though no one of these is above + 60

Among the more interesting *r*'s is the positive one between masturbation and oral play. The psychoanalysts might make much of this.

The positive association between finger play and squirming as well as body stroking, between respiratory patterns and the latter, between respiratory patterns and finger play, and between oral, nasal, and corporal-mass activities should also be called to notice It is interesting that the only negative *r* of considerable size is that between genital stimulation and finger handling

Inter-index Correlations for the Group of Girls. What we have been saying thus far concerns only the inter-index correlations for the male group It would find little support in the data derived from the girls (see Table 8). The reason for the dissimilarity in the returns from the two sex groups is not entirely clear; but it is certain, if any of the *r*'s are dependable, that a different balance of influences obtains in the case of girls than in that of boys Perhaps variances in physical structure are contributing significantly, or the cultural standards for the two sexes are rather divergent, some of the tendencies to the less aesthetic mannerisms being counteracted, for example, to a greater extent by the training the girls receive We can get no effective support, however, for this latter thesis from a comparison of the sex averages in such traits as tendencies to pick the nose or handle ears, because the girls have, if anything, a higher

TABLE 8

INTER-INDEX CORRELATIONS WITH AND WITHOUT AGE PARTIALED OUT—GIRLS

	Pedal	Caputal-hirsutal	Corporal mass	Oral	Nasal	Aural	Digital	Corporal-limited	Respira-tory
Pedal		−143	+378	−065	−322	−147	−025	+502	+310
Caputal-hirsutal	−092		−355	+012	+005	−319	−078	+017	+260
Corporal-mass	+288	−334		−062	−121	+.275	−015	+.240	+.117
Oral	+026	−.012	−011		−039	+001	−085	+169	−290
Nasal	−353	+002	−119	−045		+404	−208	000	−214
Aural	−089	−345	+333	−027	+.404		−283	−211	−165
Digital	−018	−081	−010	−090	−208	−.239		−002	−085
Corporal-limited	+445	+053	+179	+.227	+007	−181	+003		−142
Respiratory	+173	+.329	+020	−245	−219	−123	−083	−258	

mean score than the boys. We grant, of course, on the other hand, that the results of this comparison of mere frequency counts do not invalidate our hypothesis but merely make it seem less cogent.

Neither does the surprising number of negative *r*'s in Table 8, since most are not large, contradict the hypothesis just expounded; but it makes us entertain the additional thought that compensatory mechanisms may be at work Perhaps whatever needs or activities these mannerisms reflect tend to be taken care of, in the case of the girls, in a less significant variety of ways than is true of the boys It is worthy of comment in this connection that the variability among the girls is significantly larger than among the boys in the case of the caputal, oral, aural, and nasal mannerisms.

SUMMARY

By means of a short time-sample observation procedure there were obtained for each of 46 nursery-school children indexes descriptive of the child's tendency to indulge in each of 11 classes of "nervous habits" or movement mannerisms. The scores for each class of mannerisms were based on behavior noted during 400 half-minute observation periods, these scattered in time over a period of eight months. An attempt was made to view two samples of behavior daily while the nursery school was in session, though the success in this attempt was only partial

The reliability coefficients for the mannerism scores range from +.77 to +.98.

The correlations between scores based on the first and last half of the observations range from +.30 to + 91

Sex differences which are probably significant are to be noted only in the case of masturbation tendencies and proneness to finger the scalp or hair as well as to indulge in finger manipulations

More mannerisms occur, generally, in types of situations in which restraint is greatest or in which gross physical activity is least Controlled play seems to result, in most cases, in a higher mannerism toll than free play, and indoor play than outdoor There are a few exceptions to these trends, but these are, in the main, not dependable

Between the mannerism scores and the scores the parents of the children made on the Cason Inventory of Common Annoyances there seems to be little relation, except that the more annoyed or conscientious mothers seem to have daughters who tend to finger their hair, scalp, and fingers more frequently

The greater the number of playmates a child has the greater tend to be his mannerism counts Though the correlation coefficients expressive of these relationships are not large, only one negative coefficient of any size occurs—i e , that between the number of playmates the girls possess and their finger-play scores The number of sibs a child has, the number of persons in the household in which he holds membership, the number of occupants for a room in the home, and the number of residences the child has occupied from birth seem unrelated to mannerism frequency. If any association exists, we suspect that it is in a negative direction, because most of the correlation coefficients, though small, are negative.

An index of susceptibility to constipation tends to yield positive correlations with the mannerism counts. Only two of the *r*'s are, however, of probably significant size—i e , the *r*'s involving the total mannerism scores in the case of the boys and the oral scores in the case of the total group

Measures of various patterns of skin-resistance change when the subjects were under stimulation tend to yield such low correlations with measures of mannerism tendencies that few seem worthy of comment A correlation of — 389 is the largest This is the one between the size of relative skin-resistance decrease following stimulation and frequency of indulgence in finger handling among the girls

The IQ obtained from the Kuhlmann-Binet test correlates significantly only with ocular mannerisms and with hirsutal adjustments in the case of the girls' group.

The older children tend to stand on the sides of their feet more often than do the younger None of the other classes of mannerisms correlate significantly with age.

Indexes of various types of behavior having social significance were obtained in the same way as were the mannerism scores The reliability coefficients of these social behavior indexes range from +.53 to + 93, most being above +.70.

A bent toward playing alone seems positively associated among our male subjects with a tendency to masturbate, and negatively among our female subjects with proneness to play with the fingers and handle the hair.

An inclination to watch others, contrariwise, correlates negatively with a tendency to masturbate, and positively with a disposition to handle the fingers.

A tendency to pout or sulk relatively frequently correlates +.352 and +.299 with our measures of finger activity in the case of the boys and girls, respectively, and at least positively with most of the mannerism scores.

A tendency to stare vacantly seems relatively unrelated to any of our mannerism counts except the ocular.

Indexes descriptive of tendencies to attack overtly, whether directly or indirectly, tend to correlate negatively with the mannerism scores, except that for masturbation. Most of the *r*'s are low and insignificant.

Estimates of the relative degree to which our S's tended to refuse or ignore, to boss, to talk about themselves, to make much noise, grimace, act silly or swagger, show the same trends as do the measures of more clear-cut attack tendencies, as far as relationship to mannerism frequency is concerned.

Compliance and conformity trends, as estimated by us, yield less consistently negative *r*'s with the mannerism scores than do the inindexes referred to in the two preceding paragraphs. Finger activity counts and indexes of compliance are, however, negatively correlated.

Facial and primitive vocal expressiveness gauged by the observation of such behavior patterns as smiling, crying, whining, and laughing bears no relationship, except in one case, to the mannerism counts, to the extent the correlation technique uncovers this. The tendencies to cry or whine and to finger the hair seem to be associated.

The inter-mannerism correlations are higher in the case of the boys than in the case of the girls, but, in the main, they are all rather low, no *r* exceeding +.60.

The masturbation index, as far as our male group is concerned, more frequently correlates negatively with other mannerism scores than any other index.

The inter-index correlations for the male and female groups do not tend to show the same patterns.

The findings of the study suggest that many factors are contributing to the movement tendencies studied. Among the influences suspected of being significant are local irritations, degree of gross body involvement in the occupations followed, boredom, internal conflict, restraint, and degree of agressiveness. These factors, if operative, seemingly affect the different classes of mannerisms in dissimilar ways.

A multiple factor analysis is in progress.

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UNE ANALYSE DE CERTAINES FORMES DES SOI-DISANT "HABITUDES NERVEUSES" CHEZ LES JEUNES ENFANTS

(Résumé)

On a observé, quand possible, des élèves de l'école maternelle, 46 en nombre et âgés de 21 à 58 mois, pendant deux périodes d'une demi-minute chaque jour scolaire jusqu'à ce qu'on ait obtenu 400 de ces échantillons du comportement On a noté la présence ou l'absence pendant chacune de ces courtes périodes de l'observation de onze types différents des soi-disant habitudes nerveuses La tendance d'un individu à se livrer à chaque type des formes de mouvement a été indiquée par une notation—c'est-a-dire, le nombre des échantillons du comportement où la forme s'est montrée Les coefficients de cohérence (observation alternée) de ces notations ont varié de 0,77 à 0,98, tandis que les corrélations entre les notations basées sur la première moitié et la seconde motié des périodes de l'observation ont varié de 0,30 à 0,91 Quelques-unes des variables dont on a etudié la relation aux chiffres des maniérismes ont eté l'âge, le sexe, le Q I, la tendance à la constipation, le nombre de camarades, le nombre de frères ou

de soeurs, la grandeur de la maison et le peu d'espace libre là-dedans, la tendance des parents à s'ennuyer, le type de situation où l'on a observé l'enfant, les phénomès de la résistance de la peau quand le S est stimulé, et la tendance de l'enfant à attaquer, à se plier, à se conformer, à bouder, à ne faire aucun attention aux demandes, à rire, à pleurer, à pleurnicher, à sourire, à regarder les autres, à regarder fixement sans expression,à parler de lui-même, à se donner des airs ou à être niais, et à montrer l'esprit directeur

Koch

EINE ANALYSE GEWISSER FORMEN DER SOGENANNTEN "NERVÖSEN GEWOHNHEITEN" BEI JUNGEN KINDERN

(Referat)

Sechsundvierzig Kinderstubenkinder im Alter von 21 bis 58 Monaten wurden, wo moglich, fur zwei Halbperioden jeden Schultag beobachtet, bis 400 dieser Verhaltungsproben erhalten wurden Das Vorhandensein oder Nichtvorhandensein von 11 verschiedenen Arten von den sogenanten nervosen Gewohnheiten wahrend jeder der kurzen Beobachtungsperioden wurde beachtet Die Neigung des Einzelwesens, jede Art von Bewegungsgestaltung aufzuweisen, wurde durch einen Wert beschrieben, d h die Anzahl der Verhaltungsproben, in denen die Gestaltung vorkam Die Zurverlassigkeitskoeffizienten (abwechselnde Beobachtung) dieser Werte rangierten von +0,77 bis +0,98; wahrend die Korrelationen zwischen den Werten aus der ersten und letzten der Beobachtungsperioden von +0,30 bis +0,91 rangierten Einige der Varianten, deren Verhaltnis zu den Manieriertheitswerten untersuch wurde, waren Alter, Geschlecht, IQ, Neigung zur Verstopfung, Zahl der Kinder der gleichen Eltern, Grosse und Gedrange im Heim, Neigung der Eltern zum Sichargern, Natur der Situation, in der das Kind beobachtet wurde, Hautwiderstandphanomen, wenn die Versuchsperson unter Reizung ist, und de Neigung des Kindes, anzugreifen, sich zu fugen, sich anzupassen, zu schmollen, Bitten zu ignorieren, zu lachen, zu weinen, zu jammern, zu lacheln, andere zu beobachten, leer vor sich hinzusehen, uber sich selbst zu reden, einherzustolzieren oder albern zu sein, und zu befehlen

Koch

EXPERIMENTS WITH AN INFANT CHIMPANZEE*

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ADA W. YERKES

INTRODUCTION

As a basis of all psychobiological experiments in which animals are used as subjects it is imperative to know the animal thoroughly. Not only chronological age but the status of physical and mental development and conditions which have surrounded the animal from birth are of importance. In all animals activities appear at different stages, endure for a time, and disappear. The higher an animal is in the phylogenetic scale and the more it resembles man, the more necessary it is to have accurate knowledge of its nature and capabilities at different ages as a basis for the planning of experimentation and for comparison of results

Until recently little experimental work has been done with chimpanzees under three years of age. Of chimpanzees brought from Africa the age is never definitely known, it is commonly said to be three to five years. By the time such animals have been tamed sufficiently to be used as subjects in behavioral studies their infancy is past. With the arrival at the Anthropoid Experiment Station of Yale University at Orange Park, Florida, of chimpanzees from Cuba whose birth dates were known, and the birth of an infant at the Station, it became possible to measure growth and physical development of these babies and to test their mental abilities. The history of the first chimpanzee born at the Yale Station, Alpha, has been published by Jacobsen and Yoshioka (1) One of the Cuban infants for parts of two years was available to me for study. It was suggested that I conduct some experiments to keep her in practice and to serve as a suggestion of methods usable for infants of her age These experiments were of necessity brief and simple.

Among the chimpanzees presented to the Station by Mr. Pierre

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*Recommended by R M Yerkes, accepted for publication by Carl Murchison of the Editorial Board, and received in the Editorial Office, June 8, 1934.

Abreu of Havana, Cuba, was Guaimara, a name shortened at once to Gua (female, number 50). Gua was born on the Abreu estate November 15, 1930, came to the Yale Station in May, 1931, was separated from her mother, Pati, in June, and at once, at the age of seven months, was lent to visiting investigators, Dr and Mrs. W. N. Kellogg, for the experiments recorded in their book *The Ape and the Child* (2). In general this undertaking consisted in bringing up the baby chimpanzee with their infant son, two months older, under the same conditions exactly as if both were human children The Kelloggs used many and varied tests but no knowledge of their nature and results was available to the writer until most of her experiments were concluded.

In March, 1932, Gua, then sixteen months old, was returned by the Kelloggs to the Yale Station As the result of her experiences the previous year she was so well trained to experimental procedure, so much at home with the few human beings to whom she was accustomed, that she was an ideal subject of experiments. The experiments recorded here on choice-from-sample were given from April to July, 1932 Gua was also given the Gesell mental tests for human infants The following February, after an absence of six months, I renewed acquaintance with Gua who welcomed me back and at once slipped into her former pleasant relations with me From March 15 to May 24 were performed the experiments on discrimination of difference which form the second part of the present report These were followed by a study of instrumentation which will be reported elsewhere

PART I CHOICE FROM SAMPLE

History of the Method. The method of choice from sample was elaborated to an unusual degree by Mrs. Kohts (4) with her chimpanzee Ioni, who probably was about four years old when the experiments began It consists in placing before the subject a number of objects from among which the subject is required to choose one identical in every respect with a sample offered simultaneously by the experimenter. An indefinite number of variations on this simple theme can be arranged In Mrs. Kohts's experiments the subject progressed from differentiating two objects of different colors presented simultaneously to responding correctly to a large collection of numbers, colors, sizes, volumes, dimensions, lines, images, and combinations of two or more of these Young chimpanzees can be trained to the simple procedure necessary, it involves a principle of comparison which can be grasped by them. It thus becomes the basis for the study of many aspects of sensory and perceptual capacity while serving also to adapt the animal to experimental procedure and to cooperative relations with the experimenter.

Procedure In the present instance the foundation had already been laid. Gua had been trained to pick up an object and hand it to the experimenter on demand Also she was accustomed to running freely around the room but she would on no account run far away from the experimenter If she became careless a threat to leave her brought her to obedience at once. She objected so strenuously to being confined alone that no attempt was made in this experiment to put her in a cage to work through a grille, as might have been done under other circumstances

Initially in this experiment the objects for comparison were strips of cardboard 3 x 12 cm. covered with colored paper and presented in the pairs red-green, black-white, blue-yellow These cards Gua had difficulty in picking up, so wooden blocks 3 x 12 x 1½ cm. painted as above were substituted The blocks were laid on a board across the end of a table. Gua climbed to the end of the table opposite the board and approached the blocks by walking the length of the table On the way she had opportunity to compare the blocks with one held behind and above them in the hand of the experimenter. With the presentation of each new pair of colors there was a period of exploration—handling, smelling, licking, biting. When uncertain Gua often picked up and dropped one block after another, only when she definitely held one toward the experimenter and waited for it to be taken was it counted a choice. If her choice was correct, she received a bit of fruit, something not in the daily diet, and was allowed to jump down and play If unsuccessful she was given no food but was allowed to play If much disturbed by failure she would sometimes spring into my arms and cling until the new setting was ready She usually came to the experiments eagerly of her own accord.

The tests were given in series of ten trials each, one or two series a day. With each pair of colors, for example red and green, at first only two blocks were presented on the board, one red and one green, each placed the same number of times but irregularly at the right and at the left, to be compared with either a red or a green block held in the experimenter's hand. Later three blocks were presented on the board simultaneously, two red and one green or the reverse. Most of the time four blocks were used, either one green and three red, or two red and two green, or one red and three green.

Results. The preliminary experiments served to acquaint Gua with the procedure and to indicate that matching was possible. There was no evidence at first of preference for any color. What did appear very soon was a strong right-position habit. This was the more conspicuous because Gua nearly always used her left hand to pick up a block; this meant that if she approached the middle of the array her left hand crossed over to the right end. Sometimes she walked directly to the right end. It was in the effort to break up this habit that the change from cards to blocks was made, new pairs of colors tried, and finally with red-green blocks, a red was screwed down at one end of the board and a green at the other The board was reversed every five trials. The other blocks were laid down at first between the blocks which were fastened, later both between and beyond them. After trying a few times to pick up the fastened ones, Gua rarely touched them The position habit was broken up for the time being.

The next development was the habit of laying each hand on a block and presenting two almost simultaneously, the left frequently a little before the right. As her assurance increased, this habit disappeared of itself.

To reach this point had required 140 trials, all of which were more or less exploratory Conditions varied and so also results Then with the red and green blocks Gua began to work more definitely, looking at the sample, hesitating, and obviously comparing and choosing. After seven series had been given with the red-green, two blocks screwed down, the eighth series was correct in all ten trials The blocks were then unscrewed and the third series thereafter was perfect, a total of 110 trials. The black and white blocks were then used. Only eighty trials were needed for a perfect series. None of these blocks was screwed down and the position habits did not appear In the total number of trials the left block was chosen

16 times, the right 17 With the blue and yellow blocks 250 trials were required No position habits developed, but a week of dark, rainy weather disturbed her. Evidently she was not hungry. Often she chose carelessly.

After the blue-yellow trials were finished, four different colors were presented together, red, white, yellow, blue. This situation of course was more difficult to respond to. She again developed position habits, at first the left hand, then both together. Again two blocks were screwed down; a total was presented of five blocks, of at least three different colors in any one trial, four colors throughout a series She was also given less to eat prior to the experiments She became more eager for the experiment and the reward, and paid more attention to the sample. For two days her scores were 8-2, for three days 9-1, and then 10-0. A few trials were given with all of the six colors she had worked with presented simultaneously, but these had to be discontinued because of my departure for the north The total trials given are recorded thus.

Preliminary . .	140	trials,	conditions varying		
Red-green	80	"	2 blocks fastened down		
	30	"	all blocks free		
	110				
Black-white	80	"	"	"	"
Blue-yellow .	250	"	"	"	"
R- W- Y-Blue,	270	"	2 blocks fastened sometimes		

Summary The method of choice from sample is one which can be used in its simplest forms with a chimpanzee at least as young as one and a half years. By means of it a routine procedure can be established which involves considerable freedom and enough satisfaction in doing the tasks for the subject to come to them willingly of its own accord Simple as the comparison involved in this method would appear to be it yet presents certain difficulties to the young subject These can gradually be overcome. In the process, the subject tries different methods of solving the problem Gua's behavior indicated definitely that she was making comparisons and choosing deliberately.

PART II. DISCRIMINATION OF DIFFERENCE

In March, 1933, after an interval of seven months, experiments with Gua were resumed I might have followed Mrs. Kohts's example and continued to apply the method of choice from sample to a wide range of objects and qualities. Several investigators have tested the ability of various primates to discriminate form, color, and size. Notable is the work of Kohler (3) with the chimpanzee These experiments usually have involved training the animal to select an object by some one quality in which it differed from the other object or objects. It was suggested to me that since our previous experiments had been based upon comparison of likenesses the present ones should have the perception of difference as their objective. The method was determined by the earlier experiments but now no sample was shown. The objects differed markedly in size, shape, color, position and number.

Method The new experiment was begun on March 20th, when Gua was twenty-eight months old. It was given in a room in which she had played occasionally the year before. In the center of it stood a table 60 x 75 x 70 cm., formerly used as a dining table for young chimpanzees and having for that purpose a wooden seat fastened in the middle of each side. Across one end was placed a wide board on which the objects were displayed—(1) The wooden blocks with which the subject was already familiar were used, blocks 3 x 12 x 1½ cm., painted white, black, red and green, also (2) blocks 4 x 4 x 8 cm., painted green, blue, black and unpainted; (3) cubes, 4 cm., green, blue, and unpainted; (4) cylinders, 3½ x 8 cm., unpainted, (5) grey rubber bottle stoppers, diameter 3 cm. at one end, 4 cm. at the other, height 2.4 cm. These were presented in various combinations and numbers. From those presented Gua was required to select the *one* object which *differed visually from all the others*. It was never the same one more than three trials of a series in succession. In any group of objects, no matter what the shape, color, or total number presented, there was always one object which had no exact duplicate. This necessitated careful comparison by the subject of all the qualities of the object. The position of the correct object was rotated as nearly as possible evenly, right, left, middle, throughout the ten trials of a series. Usually one series was given each day. The general procedure was the same as that of the previous year.

Behavior. Before beginning the new experiment the problem of choice from sample was reviewed. It was evident that Gua remembered the situation and the procedure. She handed the blocks at once as required, but as she was too excited to stop for careful comparisons she was right only 21 times in 40 Again she came to each trial promptly, usually without waiting to be called She was notably less infantile than in the previous year, she had acquired more independence and freedom of action Her desire for play was stronger than her interest in food When a new object, or one not seen since last year, was presented she would seize it and run away with it, examine it carefully, and tempt me to take it away from her for the sake of the ensuing romp. She would run close to me, slap at me, even put the block into my hand and snatch it away again If I continued to ignore her, she would drop the block and come back to the experiment

Results It was assumed in the beginning that the simplest setting would be that in which only three objects were presented, two alike and one different. In the first series, for instance, the objects were unpainted wooden cubes and grey rubber stoppers, one versus two. The cube, when single, was to be chosen in five trials, not consecutive, the stopper in five Gua chose correctly four times. For several days she looked at my hand repeatedly as if expecting to see a sample She then developed a position habit: on the sixth day she chose the left block ten times. At intervals during the experiments she showed preference for certain objects, usually for a certain color. But the objects presented were changing constantly. By the tenth day she was working deliberately, she would sit and look at the blocks, reach out slowly and reluctantly, and if wrong turn away at once without waiting expectantly for a reward

During the first 140 trials the combination of objects was different for every series Gua's scores were very irregular and only 40% correct. A change was then made in that the same set of objects was used for several series in succession, and a bit of fruit was placed beside the correct block as an indicator In the fifth series under these conditions all choices were correct. That she did not profit more promptly by the indicator was partly due to her disinclination to choose at all, and partly to the fact that she was choosing green seven or eight times in a series

After this success Gua worked more willingly and somewhat more accurately. It then occurred to me that perhaps the simplest setting was not that involving the minimal number of objects Difference might stand out more clearly if one were contrasted with several rather than with two. Four blocks were therefore used, one versus three, and the subject was also given less food outside the experiments in order to increase her desire for the reward. In 40 trials she was right 31 times, or 77%, the last score being 9-1. The number of blocks was then further increased and a greater variety introduced; in one series for instance among five objects presented there were three different kinds, 1 versus 2 + 2. Each time the combination of objects was changed Gua's score would drop, but in the second series with that setting it would be perfect or nearly so. Combinations were used of 1 versus 4, or 5, or 6, or 1 versus 2 + 3, or 3 + 3, or 3 + 4, up to a total of ten blocks of four different kinds, 1 versus 3 + 3 +3 With more blocks than that the situation was distinctly confusing and her scores dropped.

In series 36-38 five blocks were presented, 1 versus 2 + 2, all of which were alike in size and shape (4 x 4 x 8 cm.), of three colors (green, blue, and unpainted), and standing on end. The one of each color which in its turn occurred singly was the correct one. Gua was right only 14 times in 30, that is 46%. In series 39 the four blocks lay on a long side while the correct one stood upright. She chose correctly every time Its upright position evidently brought this block into prominence. No further attempt was made to test the influence of various factors of difference but it is indicated that mass and position as well as color play important rôles.

Many interesting avenues for further experimentation had opened but interruptions occurred and work on this problem was necessarily discontinued Settings and scores are given in the following table.

Summary. The memory of previous experiments in matching sample lasted over a seven-month interval and induced the same behavior under similar conditions The subject showed increased independence and willfulness. In spite of this she generally came to experiments willingly and attended to the problem presented even when it was difficult for her. In a large proportion of cases she suc-

TABLE 1

Series	Setting	R	W	R%	Series	Setting	R	W	R%
1-14	1 versus 2	57	83	40	46	1 vs 6	9	1	90
	Change daily								
15-19	Less often	31	19	62	47	1 vs 2 + 3	9	1	90
	Signal				48-49	1 vs 3 + 3	8	2	80
20	Same	10	0	100			10	0	100
21-26	No signal	34	26	56	50	1 vs 3 + 4	8	2	80
27-31	1 versus 3	31	19	62	51	1 vs 4 + 4	9	1	90
32-35	Less food	31	9	77	52	1 vs 3 + 3 + 3	9	1	90
36-38	1 vs 2 + 2	14	16	46	53-54	1 vs 4 + 4 + 4	13	7	65
	All on end								
39	Only 1 on end	10		100	55	1 vs 2 + 2 + 2 + 2	4	6	40
40-41	1 vs 2 + 2	5	5	50	56	1 vs 2 + 2 + 2	8	2	80
		9	1	90	57	1 vs 2 + 2	8	2	80
42-43	1 vs 2 + 2	6	4	60	58	1 vs 2	4	1	80
		10	0	100	59	1 vs 2	1	4	20
44	1 vs 4	10	0	100	60	1 vs 3	4	1	80
45	1 vs 5	10	0	100	61	1 vs 2 + 2	3	2	60

ceeded in picking out the one block which differed from all the others under such complex conditions, as with seven blocks 1 versus 6, or when as many as ten blocks of four different kinds were presented. Thirteen blocks of four different kinds constituted a situation to which this infant chimpanzee failed to adapt. On the other hand a small number, as for example 1 versus 2, was difficult. Mass or number evidently was important. So was position, when it emphasized difference, as when an upright block was contrasted with prone ones. That color was of primary importance was shown by the subject's preference at intervals for certain colors.

GENERAL RESULTS

From these crude experiments with the infant chimpanzee it is evident that: (1) methods can be devised and adapted for the study of problems of behavior in chimpanzee infancy; (2) the procedures employed in the present case were useful in accustoming the subject early to experimental situations; (3) they also developed habits of observation, careful attention, and comparison; (4) they furthered the establishment of a serviceable degree of confidence in the experimenter, of obedience, and of cooperation between subject and experimenter

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EXPÉRIENCES AVEC UN TRÈS JEUNE CHIMPANZÉ

(Résumé)

Les experiences rapportées ici ont été faites avec un chimpanzé d'une date de naissance connue. Elles se composent de deux séries (1) choix d'un échantillon, (2) perception de la différence

Dans la première série on a fait choisir au sujet dans un groupe de blocs différant seulement en couleur celui semblable à un échantillon présenté par l'expérimentateur Le chimpanzé, âgé de seize à vingt mois, a reussi par cette méthode à répondre correctement à trois paires de couleurs, et à un groupe de quatre couleurs

Dans la seconde serie, donnée un an plus tard, le sujet a choisi dans un groupe d'objets différant en forme, en couleur, et en nombre, le seul objet qui n'a eu aucun double Elle a réussi même quand le nombre des objets présentés à la même fois a été dix et que le groupe s'est composé de quatre sortes différentes

Ces expériences montrent qu'un chimpanzé âgé moins de trois ans peut apprendre par l'entraînement les processus expérimentaux, les habitudes de l'observation, de l'attention et de la comparaison, et de la coopération avec l'expérimentateur Un tel entraînement est une préparation qui vaut beaucoup pour une expérimentation plus étendue. Il donne aussi à l'expérimentateur des connaissances utiles de son sujet

YERKES

EXPERIMENTE BEI EINEM JUNGEN SCHIMPANSEN

(Referat)

Die vorliegenden Experimente wurden bei einem Schimpansen von einem bekannten Geburtsdatum ausgefuhrt Sie bestehen aus zwei Reihen (1) Wahl nach Probe, (2) Wahrnehmung des Unterschiedes

In der ersten Reihe musste das Versuchstier aus einer Haufe von Blocken, die sich nur an Farbe unterschieden, einen auswahlen, der einer vom Versuchsleiter hingereichten Probe ahnlich war Dem Schimpansen, der von sechszehn bis zwanzig Monaten alt war, gelang es auf diese Weise auf drei Paare Farben und eine Gruppe von vier Farben zu reagieren.

In der zweiten Reihe, die ein Jahr spater gegeben wurde, wahlte das Versuchstier aus einer Gruppe von Gegenstanden, die sich an Gestalt, Farbe, und Anzahl unterschieden, den einen Objekt, der kein Doppel hatte Dies gelang dem Tier, auch wenn die Anzahl der auf einmal dargebotenen Objekte zehn war und die Gruppe aus vier verschiedenen Arten bestand

Diese Experimente beweisen, dass ein Schimpanse unter drei Jahren alt zum experimentellen Verfahren, zu Gewohnheiten der Beobachtung, Aufmerksamkeit und des Vergleichs, und zur Mitwirkung mit dem Versuchsleiter dressiert werden kann Solche Dressur ist eine wichtige Vorbereitung auf weitere Forschung Sie gibt dem Vl auch nutzliche Kenntnisse uber sein Versuchstier.

YERKES

A STUDY OF SOME FACTORS INFLUENCING THE DEVELOPMENT OF THE SENTENCE IN PRESCHOOL CHILDREN*

From the University of Hawaii

Madorah E. Smith

Some Factors Influencing the Development of the Sentence in Preschool Children

In a previous study of the development of language in young children (7), several interesting leads were suggested. Since then McCarthy's (3) and Piaget's (6) valuable studies of the language of children have appeared and Davis's (2) study of children's questions. The present study is an extension and development of the former study in an attempt to follow up suggested leads and to compare results with those of other investigators.

The material used includes the former 124 records of children's conversations taken at the Iowa Child Welfare Research Station's Preschool Laboratory, the Home of the Friendless, and Sunshine Mission's Day Nursery of Cedar Rapids, Iowa; to which were added 181 more records—106 taken in the same places as before in the homes of children in Cedar Rapids and Waterloo, Iowa, sixty-seven in Honolulu, Hawaii, either in the children's homes or in Kinau and Castle Kindergartens and Nursery School in the latter city, and eight from a few miscellaneous sources.

The original 124 records were all taken while the child under observation was engaged in play with other children To this series seventy-four additional records were added Another series of 107 records were taken for comparison in another situation in which the child was alone with adults in his own home or another home with which he was familiar. In neither case was the child addressed by the experimenter, as the aim was to secure a record of his spontaneous chatter. These two situations are hereafter referred to as situations C and A respectively Twenty-eight of the records taken

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*Accepted for publication by Harold E Jones of the Editorial Board and received in the Editorial Office, July 23, 1934

in situation A were contributed by Dr Gladys Palmer, psychologist at the Psychopathic Hospital in Iowa City, from records taken in the course of another investigation of hers, twelve by Mrs. C. W Irwin of Waterloo, Iowa, twenty-five by students at the Territorial Normal and Training School (now a part of the University of Hawaii) in Honolulu, the rest by the writer All records were taken according to the same rules and all were afterwards analyzed by the writer. Each one included every word and ejaculation spoken by the child during the period of observation

Except for those whose records were taken in Honolulu, the children used in the additional records were the same children or from the same sources as those in the former study. The children from Honolulu were quite comparable to those on the mainland as they were from the same classes of society and were all of white American ancestry from homes where English was the only language spoken The records of children attending a kindergarten or nursery school where bilingual children also attended were taken during the first semester of their attendance at school A check as to average performance of all Honolulu cases compared with the rest showed that the Honolulu cases averaged forty-four months in age and 3 78 words in sentence length, and the mainland cases averaged forty-four months in age and 3 83 words in sentence length

SUBJECTS

The children ranged in age from eighteen to seventy-two months. For age comparisons, they are divided into yearly and half-yearly groups When grouped by whole years, two years includes all cases from eighteen months to two years five months inclusive When grouped by half-years, two years includes all cases from twenty-one to twenty-six months inclusive; and two and a half years includes all cases from twenty-seven to thirty-two months At each age level from two to five, twenty-five records were secured in situation A and fifty in situation C, except at two years in the latter situation At two years it was not possible to secure more than forty records, on account of the relatively small attendance of non-bilingual children in the local nursery school whose records might otherwise have been added to the former series Seven children in situation A and eight in situation C were from sixty-six to seventy-two months old. The average ages in the two situations were identical (forty-four

TABLE 1
NUMBER OF CASES TAKEN AT DIFFERENT AGE LEVELS

In whole-year groups

Age groups- years months	2 18-29	3 30-41	4 42-53	5 54-65	66-72	All
In situation A	25	25	25	25	7	107
In situation C	40	50	50	50	8	198
Boys	32	35	39	40	6	153
Girls	33	40	36	35	9	152
All	65	75	75	75	15	305

In half-year groups

Age group years months	1½ 18-20	2 21-26	2½ 27-32	3 33-38	3½ 39-44	4 45-50	4½ 51-56	5 57-62	5½ 63-68	69-72
In situation A	7	11	12	12	16	10	15	9	12	3
In situation C	7	19	29	21	25	22	30	25	17	3
Boys	9	14	17	18	20	18	20	17	18	1
Girls	5	16	24	15	21	14	25	17	11	5
All	14	30	41	33	41	32	45	34	29	6

months). The greatest difference in age between children observed in the two situations was at two years where those in situation C were seven-tenths of a month the older

The Preschool Laboratory in Iowa City charged fees and was attended mainly by children of the professional and business classes. One hundred sixty-nine or 55 per cent of the records were of children in this school or of similar social status Forty-five records were of children in free or public kindergartens and thiry-one others of children in the farmer or skilled labor classes. Sixty-two or 20 per cent of all records were of children from lower social classes found in the day nursery, orphanage, or clientele of the mission. One hundred fifty-two records were of boys and 153 of girls Some of the children were observed more than once at intervals sufficient to place them in a different age group than that in which they were at the time of the previous observation and some were studied in both situations so that there were only 220 different children studied

For 200 of the records, scores on mental tests made within the year by the child concerned were available. Using the IQ of that test, the child's mental age at the time his conversation was recorded was calculated The average mental age of those children who were studied in situation A was 49 7 months, and for those in situation C, 48.7 months, and the average IQ for those in situation A was 112, for those in situation C, 109, and for the entire 200 was 110. The average IQ's at each age were at two years, 113, at three, 106, at four, 112 and at five, 111. At three and four years the IQ's in the two situations averaged almost the same, in situation A being 105 at three and 113 at four years and in situation C, 107 and 112 respectively The two- and five-year-old groups are not quite so comparable, the two-year-olds in situation A averaging 10 points lower (A=107, C=117) and the five-year-olds 13 points lower (C=119, A=106) If all the children are considered the two groups correspond closely in mental age.

Considering the social status of the children not tested, as compared with those given mental tests, there was no selection that would tend to give any marked difference in intelligence rating if all had been tested, except in the two-year-old group where a lower rating would probably have been found, as more of those in the lowest social group were not tested and the least mature children of this age in the preschool had not been tested

TABLE 2

AVERAGE NUMBER OF WORDS PER SENTENCE IN CONVERSATIONS OF 305 PRESCHOOL CHILDREN
Averages given by half-years
Words to the sentence

Age group.	years months	1½ 18-20	2 21-26	2½ 27-32	3 33-38	3½ 39-44	4 45-50	4½ 51-56	5 57-62	5½ 63-68
All cases		1.2	1.8	2.5	3.5	4.3	4.6	4.9	5.0	5.1
In situation A		1.3	2.1	2.8	3.6	4.8	5.1	5.6	6.1	5.7
In situation C		1.1	1.6	2.4	3.4	4.0	4.3	4.6	4.6	4.8
153 boys		1.2	1.5	2.4	3.3	4.3	4.4	5.0	4.9	5.4
152 girls		1.3	2.0	2.6	3.8	4.2	4.7	4.9	5.0	4.7
Former study (124 cases)			1.7	2.4	3.3	4.0	4.3	4.7	4.6	
McCarthy's averages		1.2	1.8	3.1	3.4	4.3	4.4	4.6		

TABLE 2 (*continued*)

Averages given by whole years

Age group. years	Words to the sentence 2	3	4	5	All* ages	σ of the mean at age 2	3	4	5	All ages
In situation A	2 1	3 7	5 1	6 1	4 3	19	23	20	19	.17
In situation C	1 8	3 2	4 3	4.7	3 6	15	13	09	09	.09
Difference between the two situations	0 3	0 5	0 8	1 4	0 7					
σ of the difference						.24	.26	.22	19	.19
Difference — by σ						1.25	1 93	3.63	7.34	3.68
Boys	1 6	3 3	4 5	5 2	3 8	17	15	14	.16	.13
Girls	2 2	3 4	4 7	5 0	3 9	14	17	14	.16	12
Difference between sexes	—0 6	—0 1	—0 2	0.2	—0 1					
σ of the difference						.22	22	.20	.23	18
Difference -- by σ						2.70	.42	1 00	87	56
All cases	1 9	3 4	4 6	5 1	3 9	12	12	1 00	11	085

	Difference	σ of difference	Difference — by σ
From 2 to 3 years	1 5	170	8 8
From 3 to 4 years	1 2	.156	7 7
From 4 to 5 years	0 5	.148	3.4

*Cases 66-72 months old are included in all ages

Two years in half-year groupings includes all cases from 21 months 0 days to 26 months 29 days but in whole-year groupings 2 years include all cases from 18 months 0 days to 29 months 29 days inclusive The averages in the two parts of this table therefore do not necessarily agree

The group studied then represents a group of high average intelligence from all classes of society with a larger proportion of the upper social classes than is found in the general population. They are all from homes where English is the only language spoken The three-year-old group is slightly below the other age-groups in intelligence rating.

SENTENCE LENGTH

The most readily applied single measure of the child's development in language is that of the mean number of words per sentence. This measure has been used in our previous study (7) and by Nice (5) and McCarthy (3)

In the previous study records were taken only in situation C. Comparing the averages then obtained with those of the present series obtained in the same situation, which include 74 additional cases, almost exact agreement is found, in no case does the average differ by more than one-tenth of a word (See Table 2)

The averages in situation A are consistently higher than those in situation C at each age level. This difference is statistically significant at four and five years as well as for the whole series. This might explain the longer sentence length found by Nice (5), whose conclusions are drawn from records some of which, at least, were taken in situations where only adults were present with the child. The situation is not described in all her cases. McCarthy's averages are larger than those obtained in the present study in situation C but smaller than those found for records in situation A, although her records were taken when the child was alone with the recorder She found no difference between the two situations in the 31 cases observed also in a free-play situation (4) But she appears to have directed the child's conversation more when alone with the child than was done in the present study, where it was the policy never to address the child unless necessity arose. That the direction of conversation was more marked in her study is evidenced by sample records in the appendix of her book (3) and the fact that 18 per cent of all comprehensible responses in her main study were answers, but only 8 per cent were in the free-play situation In the present study, only 5 per cent of the sentences in situation A were answers and 7 per cent in the free-play situation C As answers are usually incomplete sentences with the subject or verb understood or even a single word such as "yes," "no," or "sure," the average length of sentences in a series containing almost four times as high a percentage of answers would be shorter This might explain the discrepancy between our findings as to effect of situation on sentence length

COMPARISON OF SITUATIONS

The difference in length of sentence found in the two situations in the present study may be due to three factors First, the difference may be caused by the slightly lower percentage of answers in situation A and also of another type of sentence that tends to be shorter than the average, the imperative sentence which comprised 14 per cent of all sentences in situation A and 20 per cent in situation C. Another possible factor is the fact that more children who associated mainly with adults were observed in situation A (since the majority of those in situation C were observed at kindergarten or preschool) and McCarthy (3) has pointed out that children associating mainly with adults used longer sentences A third factor enters in that might explain the longer sentence. In situation A the child was usually occupied with toys, picture books, puzzles, or constructive material. He was less often engaged in such active play as occupied those in situation C where swing, slide, and dramatic games led to greater physical activity More often were his remarks broken off and thus shortened by another's interruptions in situation C and very seldom did he sit down and enter upon a real conversation with a playmate, with narration of experiences or a series of questions, as frequently happened in situation A Apparently an adult is some one to talk to, another child some one to play with, in the eyes of the child at this age. A situation where one sits down quietly to converse is conducive to a more connected discourse, with longer sentences and fewer incomplete ones, than a situation of physical activity, whether the participants are children or adults.

That the lengthened sentences, however, are due to the situation and not entirely, if at all, to a difference in the composition of the groups is indicated by the fact that in the case of the 20 children observed in both situations within the same week, only two failed to use a longer sentence in situation A (See Table 3) One of these, an 18-months-old baby, averaged 1.1 words in both situa-

TABLE 3

AVERAGE SCORES OF TWENTY CHILDREN STUDIED IN BOTH SITUATIONS

	Situation A	Situation C
Sentence length	4.4	3.5
Error index	15.7	16.2
Percentage of questions	11.4	8.8
Negative sentences	10.2	11.5
Imperative sentences	18.4	30.0
Complex and compound sentences	14.3	8.3
Single word sentences	11.4	18.1

tions and the other child averaged 3.2 words in situation A and 3.4 in situation C. The average sentence length for the 20 cases was 4.4 for situation A and 3.5 in the other situation. These 20 children used more complex and compound sentences and questions, and fewer single-word negative and imperative sentences in situation A, the same differences as found in the complete series.

SEX DIFFERENCES

When the additional cases in both situations are included in the averages, the difference in favor of girls found in our previous study remains and is also in their favor when the data is grouped in half-year intervals at 6 out of the 9 age levels studied, the exceptions being but one-tenth of a word in favor of the boys except at 5½ years This corresponds with McCarthy's findings, her girls excelling the boys at every age but 30 months. Her data does not include cases as old as our oldest age groups, where the only marked difference in favor of boys occurred. Grouping the data in year intervals, the sex difference is greater than three times its probable error only at 2 years of age.

There is a steady increase in sentence length with increase in age up to 4½ years in situation C and to 5 years in situation A, after which the gain is negligible in the former case and there is a drop in the latter case. Using whole-year intervals the difference is 8.8 times its σ from 2 to 3 years, 7.7 times its σ from 3 to 4 years and 3.4 times its σ from 4 to 5 years

Thirty-four children were observed more than once, for whom a total of 93 conversations had been recorded. In the case of each child all of his records were taken in the same situation. (See Table 4.) The average performance at different ages corresponded

TABLE 4

Average Scores of Thirty-Four Children Observed More Than Once

Age group years	1½	2	2½	3	3½	4	4½	5	5½	6
Number of cases	3	7	10	18	19	12	7	9	6	2
Average sentence length	1.1	2.0	2.9	3.7	4.1	4.4	4.6	4.6	5.7	5.9
Average error index	94	58	31	19	10	9	5	6	3	3½
Average per cent questions	00	6	9	11	13	12	17	15	11	15

closely with that of the complete series. Of the 59 differences between pairs of records, there were 49 times (or 83 per cent) when the record taken at the later age gave the higher average sentence length, 3 times when the two averages were identical, and 7 when the later record averaged a shorter sentence. As the interval between records differed and the correlation between sentence length and chronological age had been shown to be linear, the average half-yearly gain for each child was calculated by dividing the gain or loss between records by 6 times the number of months in the interval. Averaging these gains for each half-year for all children whose records extended over that interval, the gain from 18 months to 2 years was found to average 0.9 words for the three whose first record was taken at 18 months, for 2 to 2½ years and from that age to three, 0.9 and 0.8 words respectively; after that less than half a word each interval to 4½ years and then no gain; but the six cases in the next two half-years gained on the average 0.9 and 0.2 respectively. This series shows no gain at about the same point as the complete series, and the same lessening rapidity of gain with age.

Sentences Analysis of Construction

All sentences in the records were classified according to the usual grammatical classifications, the percentages of each type calculated for each record, and the averages found separately for each year and half-year group for each situation and for certain headings for boys and girls. (See Table 5.)

The sex differences thus calculated were significant at no age

TABLE 5

FREQUENCY OF VARIOUS TYPES OF SENTENCES IN PERCENTAGES

Age	Repetitions per sentence	Babble	Complex and compound	Single word	Declarative	Imperative	Questions	Exclamatory	Negative	"No"	"Yes"	Naming	Percentage of all "no's" that are imperative
18-29 months	23	5.3	1.6	50	59	20	6	15	7	4.5	7.5	13.2	86
30-41 months	14	1.5	6.2	17	67	18	9	6	10	2.8	2.4	4.5	42
42-53 months	8	1.5	12.5	9	63	18	14	4	13	1.8	1.9	1.3	44
54-65 months	4	1.5	17.3	5	63	15	18	4	14	0.9	1.1	1.3	25
66-72 months	3	0.2	17.1	4	75	14	9	2	11	0.8	0.6	—	33
All cases	12	1.3	10.2	18	64	18	12	7					
All in situation A	10	1.5	13.4	16	66	14	15	6	11	1.3	1.0	5	28
All in situation C	13	1.2	8.4	22	63	20	10	7	12	2.6	2.0	4	54
Difference A and C	3	3	5.0	6	3	− 6	5	− 1	− 1	1.3	1.0	1	−26
σ of difference	3.8		4.0	4.6	5.7	4.4	4.1						5.5
Difference − by σ	79		1.2	1.3	45	1.4	1.2						4.7
Difference 2 to 5	−19	−3.8	+15.7	−45	+ 4	− 5	+12	−11	+ 7			−11.9	−61
σ of difference	5.7	3.1	4.6	6.7	8.3	6.5	5.3	5.0	5.1			3.6	6.6
Difference ÷ by σ	3.3	1.2	3.4	6.7	0.5	0.8	2.3	2.2	1.4			3.3	9.2

nor for the whole series The differences were greatest at two years when the girls asked more questions, used more imperatives in situation C but fewer in situation A and more complex and compound sentences in both situations. A larger percentage of girls than of boys at two years used other than simple sentences and questions The difference in the percentages of girls and boys when divided by its standard error was in the case of questions 2 6, and in the case of other than simple sentences 2.4.

Comparing the two situations studied, the differences were all too small to be statistically significant considering the small number of cases. At every age studied questions were more frequent and, except at two years, more complex and compound sentences and fewer imperatives were used in situation A. Sentences used merely to express assent or dissent only were more frequent in situation C merely because the child was addressed more frequently.

The age differences were the most marked. From 2 to 5 years old the percentage of complex and compound sentences combined increased from .016 to 173 (D—S D =3 4), single word sentences dropped from 50 to 5 per cent (D—S D =6 7), exclamatory sentences fell from 15 to 4 per cent (D—S D.=2 2), imperative sentences fell slightly from 20 to 15 per cent, questions increased from 6 to 18 per cent (D—S D =2 3), declarative sentences rose very slightly in frequency, 59 to 63 per cent, and negative sentences doubled, 7 to 14 per cent, or, if situation A is considered alone, increased from 3 to 14 per cent (D—S D =3 1 in situation A).

In studying the sentence, it was observed that the use of the word "no" varied with age, younger children used it mainly as an imperative where the older children used "don't," and they in turn used "no" more frequently in answer to questions as a mere expression of dissent This difference is a highly significant one (D—S D =9 2), the use of "no" as an imperative falling from 86 per cent of all "no's" at two years to 25 per cent at five years Babbling or series of meaningless syllables apparently not intended to communicate ideas occurred 50 times to every thousand sentences at two years then dropped to 15 times to every thousand at each age thereafter

FUNCTIONAL ANALYSIS

Piaget's (6) valuable analysis of children's sentences has also been used by McCarthy, who added to his categories two, dramatic imitation and social phrases. All of our records for which accompanying data were sufficient to analyze according to this modified scheme were thus classified. (See Table 6) Three of Piaget's classifications were further broken up into subheads, monolog, collective monolog, and adapted information, separating in each of the three classes those sentences which merely named objects or people, and under the two latter heads separating the remarks according to whether they dealt with the immediate situation, were associated with it or seemed to be irrelevant, as was done by McCarthy in the last-named class of adapted information The usable records numbered 84 of those taken in situation A and 175 in situation C They were all of the 18- to 66-months-old children, the possible records in the older group being too few to consider. Only one statistically significant age difference was found, a drop in monolog from 25 per cent to 6 (D÷S.D =3 1). Other classifications decreasing with age were repetition and commands or requests Criticism, collective monolog, adapted information, questions and answers all increased with age, the last-named being the only class where the difference did not tend in the same direction at every age. Less than 2 per cent of the sentences fell under the subdivisions of social phrases and dramatic imitation (the latter occurring so seldom that it was not included in the table). McCarthy found the same trends in the case of adapted information and answers and she also found low percentages for dramatic imitation and social phrases except at the age of 18 months in the case of the latter class.

A far higher proportion of sentences in the records used in this study were classed as egocentric, under one of the three classes of this type, than in that by McCarthy but a considerably lower proportion than in that by Piaget Perhaps we do not all agree as to just the meaning of this term. The coefficient of egocentrism in this study fell from 40 at two years to 33 at three, and 26 at four and at five years. Piaget found a coefficient of .45 for a classroom of children from seven to eight years and McCarthy's percentages varied from 1.3 to 6.5 at different ages. The difference is due at least in part to the different situations. McCarthy's cases

TABLE 6

FREQUENCY OF VARIOUS TYPES OF SENTENCES ACCORDING TO PIAGET'S CLASSIFICATION IN PERCENTAGES

				Collective monolog					Adapted information								
Age	Number of cases	Repetive	Monolog	Immed	Assoc	Irrel	Total	Coef of ego-centricity	Immed	Assoc	Irrel	Total	Criticism	Imperative	Question	Answer	Social phrases
2	63	5	25	9	0 5	0.2	10	40	15	1	0 3	17	0 2	32	5	3	2
3	68	3	10	17	2	1	20	33	16	3	1	20	2	30	8	6	1
4	65	3	6	13	2	1	17	26	14	7	2	23	2	28	12	9	1
5	63	2	6	14	3	1	18	26	16	5	3	25	3	22	16	7	1
In situation A	84	2	13	14	2	1	17	33	17	4	2	23	1	22	15	4	1
In situation C	175	4	11	13	2	1	17	32	15	4	1	20	2	31	8	7	1
All cases	259	3	12	13	2	1	17	32	16	4	2	21	1 6	28	10	6	1
Difference 2 to 5 years		—3	—19				— 8	—14				8	2 8	—10	11	4	—1
σ of difference		3 3	6 2				6 1	8 3				7 2	2 2	7 8	5 4	3 9	
Difference — by σ		0 9	3 1				1 3	1 7				1 1	1 3	1 3	2 0	1 0	

Immed—relates to immediate situation
Assoc.—associated with immediate situation
Irrel—irrelevant to immediate situation

were in a situation very conducive to socialized speech. The experimenter talked to the child, which was not done in either Piaget's or this study. The two situations used in this study showed almost the same coefficient of egocentricity, the average for all ages being 33 and 32. But at five years, it was much lower in situation C, 23 as compared to 33, where the child had companions of his own age who were not attempting to refrain from directing conversation. The individual differences were large When a child sat down and entered into a prolonged conversation or was playing with other children at the same game the coefficient fell, especially in the case of the younger children, who more often played with their own toys or at their own games beside other children rather than cooperated with them (1, p. 243). When that was so, although he might, for example, talk about the choo-choo trains he was pushing about in the sand near another child, his comments did not appear to be of a socialized nature, seldom expecting or receiving any response unless his actions interfered with the others or theirs with his, in which case some criticism or imperative would result on the part of one or both of the children involved Piaget (6, p. 19) recognized the difficulty of distinguishing the pure and collective monologs in one of his cases He found the former type of monolog to occur 8 and 5 per cent of the time, which are exactly the averages found in the case of the 5-year-olds in this study in situations A and C respectively

Sixty-seven per cent of all conversation was connected with the immediate situation, 24 per cent associated with and 9 per cent was apparently irrelevant to the situation. The relative ranks of these three classes are the same as found by McCarthy in her subdivisions of adapted information. A higher percentage of the conversation of the younger children was connected with the immediate situation

Naming composed 13 2 per cent of all sentences at two and 1.3 at five (D—S D.=3.3) This decrease was also found by McCarthy and if her figures for naming given under the head of adapted information are altered to give the percentage for all sentences, the averages are found to differ but little. The naming changed in type also from a monolog as the child wandered about the room naming objects he saw or handled to naming that was given for the information of others.

PARTS OF SPEECH

Each record was analyzed as to parts of speech following the usual grammatical rules As noted before by McCarthy and in Smith's previous study, this is very difficult in the case of the more immature children who use one word expressive of a whole sentence In such cases, the words were classified according to their most common use The percentage of each part of speech in each record was calculated and the percentages found averaged for each whole year age-group separately and together for each situation (See Table 7)

TABLE 7

COMPARISON OF THE PERCENTAGES OF RELATIVE FREQUENCY OF THE DIFFERENT PARTS OF SPEECH AT DIFFERENT AGE LEVELS

				Months			Difference	
Age	18-29		30-41	42-53	54-65		2 to 5 years	
	Av	σ	Av	Av.	Av	σ	Diff	σ of diff.
Substantives	41	6 1	40	40	39	5 6	— 2	8 3
Nouns	28	5 6	18	16	15	4 1	—13	6 9
Pronouns	13	4 2	23	24	24	4 9	+11	6.5
Verbs	23	5 2	26	26	27	5 1	+ 4	7 3
Modifiers	23	5 2	24	23	24	4 9	+ 1	7 1
Adjectives	4	2 4	6	7	8	3 1	+ 4	3 9
Articles	1	1 2	3	4	5	2 5	+ 4	2 8
Adverbs	18	4 8	16	12	12	3 3	— 6	5 8
Interjections	10 2	3 8	3 5	2 1	1.8	1 5	— 8 4	4 1
Connectives	2 1	1 8	6 2	9 2	9 8	3 4	+ 7 7	3 8
Conjunctions	0 3		1 6	2 2	2 5		+ 2 2	
Prepositions	1 8		4.4	6 5	6 4		+ 4.6	
*Relatives	0 0		0.2	0 5	0 9		+ 0.9	

*Relative adverbs and pronouns are included under the heads both of connectives and either adverbs or pronouns, therefore if the percentage of relatives is included in totals, the sum of the percentages will be greater than 100

In order of decreasing frequency for the whole group, the parts of speech run verbs, pronouns, nouns, adverbs, adjectives, prepositions, interjections, and conjunctions. Grouping these parts of speech into five classes—substantives, verbs, modifiers, connectives, and interjections—their relative frequency is shown in the order named in this sentence and the differences between each pair exceeds its σ by more than three, except the differences between verb and modifiers and between conjunctions and interjections.

TABLE 8

COMPARISON IN PERCENTAGES OF FREQUENCY OF THE DIFFERENT PARTS OF SPEECH ACCORDING TO THE SITUATION IN WHICH THE RECORD WAS TAKEN

	Situation				*Difference*		*All cases*	
	A		C		A-C			
Part of speech	Av	σ	Av	σ		σ of diff	Av	σ
Substantives	37	4.6	41	3.5	4	5.9	39	2.8
Nouns	20	3.8	18	2.7	2	4.7	19	2.2
Pronouns	17	3.6	23	3.0	6	4.7	20	2.3
Verbs	26	4.2	26	3.1	0	5.2	26	2.5
Modifiers	25	4.2	23	3.0	2	5.2	24	2.5
Adjectives	7		6		1		6	1.4
Articles	4		3		1		3	1.0
Adverbs	14		14		0		14	2.0
Interjections	10.2	3.8	3.5	1.5	1.4	2.2	4	1.1
Connectives	2.1	1.8	6.2	1.7	1.5	3.1	7	1.5
Conjunctions	1.9		1.7				2	0.8
Prepositions	5.6		4.2				5	1.2
Relatives	0.4		0.5				0.4	0.2

Comparisons made between the two situations (Table 8) showed no significant differences in any case. At each age level there was a consistent tendency to use more adjectives and connectives, fewer pronouns and fewer interjections in situation A than in situation C. The difference in the use of inflected forms was also at each age in favor of situation A.

Comparisons from year to year showed no significant differences in the percentages of different parts of speech. The trend is the same as that found in the previous study, and as in McCarthy's, except for adverbs. The percentage of nouns, interjections and adverbs decreased from year to year except that adverbs ceased to decrease from 4 to 5 years Adjectives, conjunctions, prepositions, and pronouns increased from year to year except in the case of pronouns, which gave the same proportion at four and at five. Verbs show very slight increases at two ages. The proportions of each part of speech changed *not more than one* per *cent* in any case from 4 to 5 years When all connectives are combined, the difference between the percentages at 2 and at 5 years is just twice its standard deviation.

Further subdivisions of the parts of speech into their classes were *made and studied.* (See Tables 9 and 10) The significance differences found from year to year (that is, those where the difference

Age group Years	2		3	4	5		Difference 2 to 5 years			All cases
	Av	σ_p			Av	σ_p	Diff		σ diff	percentage
Of verbs, percentage that are										
Infinitives	2	1 7	5	7	7	2 6	5	2 9	1 7	6
Participles present	3	2 1	6	6	6	2 3	3	3 1	1 0	5
Participles past	4	2 4	2	1	1	1 1	—3	2 7	1 1	3
Auxiliaries	3	2 1	8	13	16	4 1	13	4 6	2 8	10
Past	6	2 9	5	7	10	3 5	4	4 5	8	7
Future	0 2	0 6	1 3	3 0	4 6	2 4	4 4	2 5	1 8	2 3
Passive	0 0	0.0	0 5	0 6	0 4	0 8	0 4	0 8	0 5	0 4
All conjugated forms	17 7	4 7	25 9	39 1	47 4	5 8	29 7	7.5	4 0	34
Of pronouns, percentage that are										
Personal	73	5 5	77	80	81	5 0	8	7 5	1 1	78
Demonstrative	22	5 1	15	11	11	3 6	—11	6 3	1 7	14
Interrogative	3	2 9	4	3	3	2 0	0	2 9	—	4
Others	1	1.2	4	5	5	2.5	4	2 8	1 4	4
Of nouns, percentage that are										
Abstract, etc	3	2 1	7	12	19	5 0	16	5 4	3 0	11
Plural	6	2 9	7	9	11	3 6	5	4 7	1 1	8
Possessive	1	1.2	1	2	2	1 6	1	2 4	0 4	1
Of adverbs and adjectives, percentage that are										
Comparative and superlative	2	1 7	2	2	3	2 0	1	2 6	0 4	2
Of adverbs, percentage that are										
Place and modal	89	3.9	76	67	62	5 6	—27	6 8	4.0	73
Of adjectives, percentage that are										
Qualitative	67	5 8	37	49	49	5 8	—18	8.2	2.2	48
Of articles, percentage that are										
Definite	19	4 9	45	53	48	5.8	+29	7 5	3 9	46

TABLE 10

COMPARISON IN PERCENTAGES OF THE USE OF INFLECTED FORMS IN THE DIFFERENT SITUATIONS

	Situation				Difference	
	A Av	σ_p	C Av	σ_p	Diff.	σ_{diff}
Of verbs, percentage that are						
Infinitives	6		5		1	
Participles present	6		3		3	
Participles past	5		2		3	
Auxiliaries	11		10		1	
Past	7		7		0	
Future	2.6		2.2		0.4	
Passive	0.4		0.4		0.0	
All conjugated forms	40	4.7	33	3.3	7	5.7
Of pronouns, percentage that are						
Personal	79	2.8	78	2.9	1	
Demonstrative	13	3.3	15	2.5	—2	
Interrogative	5	2.1	3		2	
Others	4		5		—1	
Of nouns, percentage that are						
Abstract, etc	13	3.3	10	2.1	3	4.7
Plural	12	3.1	7	1.8	5	3.6
Possessive	1		2		—1	
Of adverbs and adjectives, percentage that are						
Comparative and superlative	2		2		0	
Of adverbs, percentage that are						
Place and modal	69	4.4	74	3.1	5	5.4
Of adjectives, percentage that are						
Qualitative	52	4.8	46	3.5	6	5.9
Of articles, percentage that are						
Definite	51	4.8	42	3.5	9	5.9

was greater than three times its standard deviation) were a decrease in the number of adverbs that were place and modal as compared with other classes and an increase in the number used of abstract nouns, of the definite article in proportion to the indefinite, and of adjectives other than qualitative from 2 to 3 years, after which the proportion increases but slightly in the case of the articles and is in the opposite direction in the other case Other consistent but not significant differences found were an increasing use of personal and indefinite pronouns paralleling a decreasing proportion of demonstrative pronouns.

Comparisons were also made as to the use of inflected forms. In the case of verbs, the proportion of conjugated forms of all types whether formed by the use of auxiliary verbs or by change in the verb-ending increased from 17 7 at two years to 47 4 at five years (D—S.D.=4.0) The participles were the earliest inflected forms to appear. The proportion of past participles to all verbs actually decreased with age, while the proportion of present participles reached the maximum at 3 years and remained constant thereafter. In the study of errors these forms of the verb were responsible for the smallest number of errors of every inflected form but the passive, which at no age reaches a proportion of even one per cent of the verbs. The early use of the past participle is probably due to its presence in learned phrases such as "all gone" and "all done" rather than to any true ability to inflect verbs The present participle was used by 21 and the past by 10 two-year-olds.

The past tense is the next mastered. The proportion almost doubles from two to five but in the study of errors we find a greater difference in its mastery—the difficulty lying primarily with the irregular verbs as some children can generalize as early as two years and so are able to form the past tense of the regular verbs correctly This tense was found in the records of 23 two-year-olds but the second highest number of errors was made in its use. Auxiliary verbs were used by 27 two-year-olds, the youngest child to use such verbs being 24 months old. However, their use caused the greatest number of all verb errors. The future tense was used by only 5 two-year-olds and by 3 of these in contracted form only. The proportion increases rapidly to 23 times as large a number at five as at two years old Even then it is next to the least frequently used verb inflection, the passive being the only form less frequently used. The youngest child to use it was 34 months old. Instead of the correct passive, the children used the verb "got" or "get" as "it got made" The infinitive gave considerable trouble, appearing for the first time at 23 months, being used by but 9 two-year-olds and causing a goodly number of errors. No further increase in its use is found after four years

Increased use of inflection of nouns was not so great as to give a significant difference with age. Still plurals and possessives were almost twice as frequent at 5 as at 2 years. No plurals were used before 24 months and only four children in the youngest age group—two each at 24 and 29 months—used possessives of nouns.

Comparison of adjectives or adverbs occurred but seldom and in no case did the comparative and superlative forms of these two parts of speech combined appear in as much as 3 per cent of the total number of adjectives and adverbs (articles are excluded in calculating this percentage). Most of those that were used were words compared irregularly so that the forms are learned as separate words. In the youngest age group this was true of all cases and without exception the word used was more.

ERRORS

For each record an error index was calculated by dividing the number of errors made by the number of words used. The indices ranged from 1.00 in the case of the records made by the most immature children to .00 in the case of the perfect records. Averaging the indices at each age level, we find a very abrupt falling off from .58 at two to .21 at three, .07 at four and then very slight improvement, the average being .05 for both the oldest age groups. As in other criteria of language development, there was no sex difference found for the group as a whole; but at two years, the girls made fewer errors than did the boys. The average indices in the two situations were practically identical.

FACTORS AFFECTING LANGUAGE DEVELOPMENT

Three criteria which had shown the most significant differences were selected as measures of the comparative effect of different possible factors on the language development. These were sentence length, percentage of questions asked to sentences used, and index of error. The relationship of these criteria to each other and to mental age, chronological age, sex, order of birth, and social class were studied.

MENTAL AGE

For two hundred cases, mental test scores were available and using these correlations between chronological age, mental age, percentage of questions, sentence length, and error index were calculated,

TABLE 11

CORRELATIONS OF CERTAIN FACTORS IN DEVELOPMENT OF LANGUAGE WITH CERTAIN CRITERIA

	With error index			First order		
	η_{yx}	η_{xy}	r	With C A	With S L	With questions
Mental age	.74	79	—.63	77± 019	73± 022	42± 039
Chronological age	68	.75	— 65		.71±.024	40± 040
Sentence length	.85	91	—.76			51± 035
Percentage of questions	43	42	—.34			

Third order

Correlation of		Partialled out
M A and C A	52± 035	S L. and Q
M A and S L	.39± 040	C A and Q
M A and Q	05± 048	C A and S L
C A and S.L	29± 043	M A and Q
C A and Q	03±.048	M A and S L
S L and Q	30± 043	M A and C. A.

The error-index scores when plotted against the other variables were decidedly non-linear in appearance, so the correlation ratios η_{xy} and η_{yx} were calculated instead By Blakeman's test, it was proved that, except in the case of questions, the relation of error-index with other factors was curvilinear (See Table 11.) The closest relation of error-index was with sentence length, as would be expected since a high percentage of the errors were in the omission of essential words in the sentence. The relation with mental age was closer than with chronological age.

Mental age correlated more highly than chronological age with sentence length and percentage of questions. The correlation of questions with either mental or chronological age is negligible when sentence length is partialled out Evidently the increase of questioning with age found by averaging the percentage of questions at each year is due rather to general improvement in the use of sentences than to either mental or chronological age

The comparatively high correlation between mental age and error-index and sentence length suggests that the Stanford-Binet score is, in the preschool years, very closely related to the child's progress in language, as measured as well by this use of longer sentences and by elimination of errors, as by vocabulary [as Terman (8, p 230) points out in the case of older children and as was found in Smith's (7) study of a vocabulary test for preschool children].

SOCIAL CLASSES

In each age group the children were divided into 3 groups· class I represented by cases from the preschool laboratory and children of similar background, class II by the free kindergartens and skilled labor groups, and class III by the day-nursery group and children of similar background The averages of the 3 criteria for measuring progress in language were found for each group

The most marked differences found were in sentence length. Class I in every case and at every age and in both situations used longer sentences than did the other two classes. The differences ranged from .4 word at 4 and 5 years in situation C to 2.2 in situation A at 3 years when compared with class III and from .3 in situation A at 2 years to 2 1 at the highest age level in the same situation when compared with class II In situation A, class II excelled class III in sentence length except at the highest age level where class III was represented by but one case, but the differences found in situation C were not consistent and almost balance each other.

Class I asked by far the most questions, the average percentage of questions being greater in both situations at each age when compared with class III and being exceeded only once out of 9 times when compared with class II At 4 years in situation C, class II averaged 1 per cent higher than class I but in this group, class II averaged two months older. Class II asked more questions at each age in situation A than did class III but again the differences were inconsistent in situation C It was noticed in scanning the records that the children at the Day Nursery and Home more frequently turned from their playmates to attempt conversation with the observer than was the case in the preschool and kindergartens where the children were more accustomed to visitors This causes the situation in their case to be less clearly marked off from situation A and to approach it somewhat in similarity, a condition that would tend to result in longer sentences and more questions The difference found between the two situations is less marked in the case of class III than in either of the other two classes.

TABLE 12

COMPARISON OF THREE SOCIAL CLASSES AVERAGE SCORES ON THREE CRITERIA

	Class I					Class II					Class III				
		Years			Months		Years			Months		Years			Months
Age	2	3	4	5	66-72	2	3	4	5	66-72	2	3	4	5	66-72
						In situation A									
No of cases	12	13	10	18	1	11	10	11	6	5	2	2	4	1	1
Av C.A in months	24	37	47	60	71	25	35	47	62	68	24	36	48	54	70
Av no of words per sentence	2.5	4.1	5.4	6.2	7.3	2.2	3.3	4.9	5.7	5.2	1.8	1.9	4.8	4.9	5.3
Av error index	57	12	6	5	0	68	28	6	2½	6	53	19	8	8	7
Av percent of questions	10	11	21	30	26	8	11	14	15	6	5	8	6	7	6
						In situation C									
No of cases	23	27	29	23	0	10	10	10	14	3	7	13	11	13	5
Av C A in months	27	38	48	59	—	21	33	50	63	67	25	38	48	51	70
Av no of words per sentence	2.2	3.6	4.5	4.9	—	1.2	2.6	4.0	4.5	5.1	1.3	2.8	4.1	4.5	4.6
Av error index	46	15	7	4	—	84	26	8	6	4	72	24	9	8	6
Av percent of questions	5	9	16	16	—	2	6	17	11	7	2	8	10	12	11

The error index was lower for class I than for class II at three age levels, higher at 5 years, and equal at four in situation A, but in situation C it was decidedly lower at each age level. Compared with class III, the percentage of errors was less in all but one of the nine comparisons possible (at 6 years there was no child in class I in situation C), the exception being at two years in situation A in which group there were but two children of class III. Comparing classes II and III, the former excels the latter at 4, 5 and 6 years old, but at 2 and 3 years their error index is slightly lower in both situations. Apparently, the later progress in correct speech is more affected by the social class of the child's parents than are the first steps.

Order of Birth

Comparison of first- and later-born children was made only in the case of sentence length. For this comparison all children were paired as closely as possible as to C.A., IQ if known, social class, and the records of both members of each pair had been taken in the same situation except for 4 pairs of children under 22 months where practically no difference is found between the two situations.

Seventy-one such pairs were found of the same sex who did not differ more than one month in C.A. in the case of those below 5 years, nor more than two months in the case of the older group, and whose IQ's did not differ enough to throw them into different categories of brightness. As the difference between the sexes had been shown to be but slight, except in the case of the younger children, 18 additional pairs of unlike sex were also added. In most of the pairs the boy was the first-born child.

The average age of the first-born and later-born members of the pairs were identical, being 40.6 months in the case of the like-sex pairs and 41.9 months in the case of the 89 pairs. The average IQ of the first-born was 121, of the later-born 119. The difference in sentence length was .08 in favor of the later-born if only like-sex pairs are used, but .04 if all cases are included. But if only the 23 like-sex pairs of 2 and 2½ years are used, the difference was in favor of the first-born children by .10 word. The average sentence length of all pairs was 3.6 words, but of the 23 younger pairs it is 1.98, so the latter difference in the case of the younger pairs is really more significant. The fact that this difference favors the first-born in the case of the younger children and the later-born in the case of the older children would indicate that the influence exerted by birth order on language, if any, is due to the more exclusive adult companionship of the first-born child in his early years, which is advantageous to early progress in speech, an influence less marked as he grows older and has perhaps younger brothers and sisters or, as was the case of the majority of these children, he begins to mingle more often with other children in kindergarten or nursery school. Although the cases are too few to be significant, this difference if confirmed by further studies would indicate that a child learns more of language from an adult than from other children. This is in agreement with the higher averages found in situation A and in McCarthy's comparison of the language sentence length of children with adult associates as contrasted with children whose associates were mainly children.

Relation of Sentence Length and Size of Vocabulary

The number of words in the vocabularies of 99 of the children was determined either by actual count in the case of 7 of the youngest or by scores on the Smith vocabulary test for the other 92. The correlation between the number of words in vocabulary and the average number of words per sentence was for the 70 children whose records of conversation were made in situation C, .767± 033, and for the 29 in situation A, 775±.048.

The average number of words in the vocabularies of children in situation C whose average length of sentence was from 1.0 to 1.9 words was 115 words, for those whose sentence length was 2.0 to 2 9 words, the vocabulary averaged 565 words; for sentences of 3.0 to 3.9, 1090 words, sentences of 4 0 to 4.9, 1802 words and for 5 0 to 5.9, 1773 words In situation C, the five-word sentence did not denote a larger vocabulary and when these cases were excluded, the correlation between number of words in vocabulary and average number of words per sentence rose to .881±.019. The average size of vocabulary found for the children using each length of sentence in situation A was less than in situation C For those using two-word sentences the average number of words in the vocabulary was 409, for those using three-word sentences 963; for those using four-word sentences 1610, for those using five-word sentences 1605 (a drop as in the other situation); for those using longer than five-word sentences 2156 Since the child in situation

C must have a larger vocabulary before he uses sentences of greater length than in situation A (for example, with a vocabulary of approximately 1000 words the average sentence length would be 4+ in situation A and 3+ in situation C), it would appear that children of equal facility in language tend to use a slightly longer sentence when conversing with adults than when with children.

The correlations between these two factors is sufficient to show that the average number of words in a sample of a child's speech is a useful measure of his progress and is to some extent indicative of the size of his vocabulary.

SUMMARY AND CONCLUSIONS

This investigation is a study of the development of the sentence and of factors influencing such development as discovered by analysis of 305 records of the conversation of 220 children ranging from 18 to 72 months in age.

Age Differences. Differences with increase in age that were found to be statistically significant were.

1 A longer sentence.

2. Increased use of compound and complex sentences and of negative sentences with decrease in the use of one-word sentences.

3. "No" more frequently used in answers or as dissent and less often as an imperative instead of "don't"

4. A lower percentage of monolog

5. Fewer sentences that were merely naming.

6. More repetitions of words or phrases per sentence

7 Greater use of inflected forms of verbs

8. An increase in the use of abstract nouns, the definite article, and of adjectives.

9 A decreased proportion of adverbs of place, modal adverbs, qualitative adjectives.

10 A decrease in the number of errors per word

Other age differences found that showed increases with age were.

11. Fewer exclamatory and imperative sentences.

12 More questions, answers, and criticism

13. A decrease from 40 to 26 in the coefficient of egocentrism

14 A higher proportion of conversation not connected with the immediate situation

15. A smaller proportion of nouns, interjections, and adverbs

16 A larger proportion of adjectives, connectives, and pronouns

17 Increased proportion of personal and indefinite pronouns paralleling a decreased proportion of demonstrative pronouns

18 Increased use of plurals and possessives of nouns and of comparison of adverbs and adjectives

19. Many of the age differences were very small or ceased after four years

20. The correlation of chronological age with error-index was non-linear, η_{xy} being .68; η_{yx}, 75.

21. The correlation of chronological age with sentence length was 71± 024, and with mental age and proportion of questions held constant, .29±.043, that of chronological age with proportion of questions 40± 040, but only 03± 048 when mental age and sentence lengths were held constant.

Situation In situation A the child was alone with adults, in situation C he was at play with other preschool children. In situation A, the child used

1 Longer sentences.

2 More questions, more complex and compound and fewer imperative sentences

The first of the above differences was the only one that was statistically significant

Sex Differences Sex differences found were not great but

1 At two years, the girls' sentences were significantly longer than the boys'.

2 Except at five years, the girls' sentences averaged slightly longer than did the boys' sentences

3. Differences as to kind of sentences were in no case nor at any age significant but at two years the girls asked more questions, used more imperatives in situation C, less in situation A and more complex and compound sentences in both situations.

4 Fewer errors were made by girls at two years of age.

Mental Age The correlation of mental age with sentence length and error index and percentage of questions was higher than that of chronological age with any of these criteria

1. The correlation of mental age with sentence length, questions and chronological age held constant, was 39±.040, with questions—sentence length and C A. constant—it was .05± 048,
2. The correlation of mental age and error index was non-linear; η_{xy} was .74 and η_{yx} was 79.

Social Classes The children were divided roughly into three social classes

1. The most marked difference was in sentence length, the higher classes using longer sentences.
2. The higher classes also asked more questions and made fewer errors.

Order of Birth. When first- and later-born children were paired on the basis of chronological and mental ages and social class, the sentence length favored very slightly the later-born child if all ages were considered but the first-born if only the younger pairs were considered.

Vocabulary. Sentence length and vocabulary correlated 77±.03 in situation C, or .88±.02, if the longest sentences were excluded; and .78±.05 in situation A.

CONCLUSIONS

1. The most useful criteria of improvement in speech were found to be the average number of words per sentence and the error index or average number of errors per word
2. Improvement is shown in many ways as related to chronological age but mental age is a more important factor in improvement.
3. Sex differences are very slight except at two years where girls excel boys.
4. Association with adults tends to improve speech more than association with other children
5. Children of the higher social classes are more precocious in language development than are those of less-favored classes.
6. Order of birth has very slight if any influence
7. Sentence length is indicative of size of vocabulary.

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UNE ÉTUDE DE QUELQUES FACTEURS QUI INFLUENCENT LE DÉVELOPPEMENT DE LA PHRASE CHEZ LES ENFANTS DE L'ÂGE PRÉSCOLAIRE

(Résumé)

Cette enquête est une étude du développement de la phrase et des facteurs qui influencent ce développement selon l'analyse de 305 notations mot pour mot de la conversation de 220 enfants âgés de dix-huit à soixante-douze mois

On a constaté que les critéres les plus utiles du perfectionnement de la parole sont le nombre moyen de mots dans chaque phrase et l'indice des erreurs ou le nombre moyen d'erreurs dans chaque mot D'autres différences corrélées avec l'âge sont le plus grand emploi des phrases composées et complexes et des phrases négatives, le plus grand emploi des formes conjuguées des verbes, des noms abstraits, de l'article défini et des adjectifs et de plus de questions comme l'enfant devient plus âgé, accompagnées d'un décroît du monologue, des phrases qui nomment seulement, de la répétition, et des adverbes de position et de mode en proportion des autres

Bien que le perfectionnement ait une relation avec l'âge chronologique, l'âge mental est un plus grand facteur du perfectionnement Les filles ont été supérieures aux garçons à la plupart des âges étudiés mais la différence a été petite sauf à l'âge de deux ans

On a étudié deux situations quand l'enfant a été seul avec des adultes et quand il a joué avec d'autres enfants de l'âge préscolaire Dans la première situation il se sert de plus longues phrases et pose plus de questions Il paraîtrait que l'association avec les adultes tend à perfectionner la parole plus que l'association avec d'autres enfants

Les enfants des classes sociales les plus élevées sont plus précoces dans le développement de la parole que ceux des classes moins élevées. L'ordre de naissance a très peu d'influence ou nulle influence. La longueur de la phrase indique la grandeur du vocabulaire.

SMITH

EINE UNTERSUCHUNG EINIGER FAKTOREN, WELCHE DIE ENTWICKLUNG DES SATZES BEI VORSCHULPFLICHTIGEN KINDERN BEEINFLUSSEN

(Referat)

Diese Arbeit zielt darauf hin, die Entwicklung des Satzes und die Faktoren zu untersuchen, die solche Entwicklung beeinflussen, die durch eine Analyse von 305 wortlichen Protokollen der Gesprache von 220 Kindern im Alter von achtzehn bis zweiundsiebzig Monaten gewonnen wurden.

Die brauchbarsten Kriterien der Vervollkommung der Sprache stellten sich als die Durchschnittszahl der Worter pro Satz und der Fehlerindex oder Durchschnittszahl der Fehler pro wort heraus. Andere Unterschiede, die mit dem Alter korreliert waren, werden durch den Gebrauch von zusammengesetzten und verwickelten Satzen und von verneinenden Satzen, den grosseren Gebrauch von Abwandlungsformen der Verben, von abstrakten Substantiven, dem bestimmten Artikel und Adjektiven und mehr Fragen, wie das Kind alter wird, zusammen mit einer Abnahme des Monologes, von Satzen, die bloss etwas nennen, von Wiederholungen und von Adverben von Platz und Zeit und von modalen Adverben im Verhaltnis zu anderen vermehrt.

Obgleich die Vervollkommung sich auf chronologisches Alter bezieht, ist das geistige Alter mehr ein Faktor der Vervollkommung. Madchen waren den Knaben bei fast allen Altern, die untersucht wurden, uberlegen, aber der Unterschied war klein ausser dem Alter von zwei Jahren.

Zwei Situationen wurden untersucht: wenn das Kind allein mit Erwachsenen zusammen war und wenn es mit anderen vorschulpflichtigen Kindern spielte. In der ersten Situation gebraucht es langere Satze und stellt mehr Fragen. Es scheint, dass der Verkehr mit Erwachsenen die Sprache mehr zu vervollkommen neigt als beim Verkehr mit anderen Kindern.

Kinder aus hoheren sozialen Gruppen sind fruhreifer in der Sprachenentwicklung als die aus den weniger gunstigen Klassen. Die Reihenfolge der Geburt hat sehr wenig Einfluss, wenn uberhaupt einen Einfluss. Die Lange der Satze ist bedeutend fur den Umfang des Wortschatzes.

SMITH

INFLUENCE OF KNOWLEDGE AND INSTRUCTIONS ON MAZE PERFORMANCE*

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I PROBLEM

Several maze investigations have attacked the problem of methods used in learning. In these we often see a note among the various controls that the subjects had never before learned a maze, that they were given no instructions, and that everything was so arranged that they started learning from as near to a zero point as possible

Supposedly, learning investigations are designed to shed light on some aspect of efficiency or to help solve some theoretical question, either for present or possible future application, direct or indirect. Unless we assume that learning studies are done merely for the sake of pure science, maze research is in a rather peculiar position Ordinarily learning is not carried on blindly, without knowledge, and once only We write English compositions for years, we study mathematics of various types all the way through school, and we spend years on foreign languages. Improved methods carried on from the outset should assist performance all along.

Applied strictly to maze learning, our present problem is how performance would be altered if the subjects knew just what they were up against, understood the idea of the maze, and were told what methods of learning had been proved to be most efficient. The writer in two previous studies (1, 2) has demonstrated that a verbal or counting method is by far the most efficient means of learning the pattern according to all scores· trials to learn, errors, time consumed, and retention value. The motor or kinaesthetic method is very inefficient in all these A visual method seems to be intermediate in value, although the variability is so high that it would seem as if some special ability were necessary to use this procedure at all.

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*Accepted for publication by Carl Murchison of the Editorial Board and received in the Editorial Office, July 30, 1934

II TECHNIQUE

In conducting a course in Experimental Psychology, the writer was usually very careful to avoid detailed discussion of maze learning until after the class had done an experiment on this topic However, during one semester it was decided to study the effects of full information upon speed of learning As learning was a regular major topic, mazes were featured to a considerable extent. While various types of learning apparatus were being discussed, a whole hour was devoted to maze patterns of various designs In fact, mazes of both styles used in this investigation were displayed to the class Different patterns were shown, however, so there could have been no learning of the correct sequence of turns.

Next, six to eight hours were occupied in discussing points of efficiency of learning—mostly the usual Educational Psychology problems. One whole hour in this series was used to discuss the results of the writer's previous study (1). Statistics were presented and the results evaluated completely Nothing at all was held back.

The result was that when the class was put through the experiment, a few days after the lecture on the subject, no formal instructions were necessary The subjects were blindfolded and started learning immediately; the only information necessary was to tell whether the U or X pattern was being presented. They were not ordered, or even advised, to use the verbal method or to avoid the motor method, since we did not wish to carry the instructions this far, but rather wished to see how much profit each subject had derived from the lecture.

The usual technique, as described in previous articles, was followed The criterion was three successive errorless trials, or three out of four. After learning had been completed, they were questioned as to how they had gone about their learning task.

The results of this test are compared with data obtained at Stanford University, and included in the previous report. This group shall be referred to as the control or uninstructed group. Comparing students from two universities may introduce an additional variable, especially since Stanford has somewhat more stringent entrance requirements than Wisconsin. But maze learning has been found to be so slightly correlated with intelligence that minor group differences should amount to little, if any. The writer might also comment that he had used the maze as a routine experiment for classes for three previous years, and had observed no real differences between the Wisconsin students and those at Stanford.

The experimental or instructed groups contained 25 and 24, for the U and X mazes, while in the control groups, 20 learned each pattern

III Apparatus

Two mazes were used, both having the same sequence of turns One was built in the U style, first described by Warden (4). The other was in the Miles X pattern (3). In this latter, the sequence was the same, but the X or Diamond construction brought the subject back to the median line of the maze after each turn, so direction orientation was minimized Such a pattern seems to handicap decidedly the kinaesthetic method, and predisposes a person to count the turns more than does the U or other design. This was seen both in our previous study and in the results of the present investigation. It was for this reason that we used two varieties of mazes

IV. Results

There are several trends apparent in the results.

1. By all counts, the instructed group learned with decidedly greater speed than the group which started with no information. Every subject, however, did not profit equally. The gains which appeared in the averages were caused almost entirely by those who started to apply the recommended procedure right from the outset. On the other hand, a good many of the subjects were either careless or lacking in insight and did no better than if they had started learning in an entirely naive state Statistical evidence of this is afforded by the discrepancies between the mean and median scores, in errors and time, especially on the X maze. One recognizes that this means that most subjects did better, but that some did so poorly that the means were higher than the medians, which latter score ignores a few extreme cases Also, a number of the instructed subjects learned the patterns in only a very few trials in addition to the three perfect, while only occasionally does an uninstructed subject learn with such great rapidity.

TABLE 1

MEAN SCORES

	Instructed		Uninstructed	
	U	X	U	X-maze
Trials	12.2	13.5	16.7	16.1
Errors	21.9	28.0	38.7	36.6
Time (sec.)	385.6	526.9	526	530

TABLE 2

MEDIAN SCORES

	Instructed		Uninstructed	
	U	X	U	X-maze
Trials	12	8.5	17	12
Errors	17	13	22.5	22.5
Time	352	262	467	381

TABLE 3

PERCENTAGES OF SUBJECTS USING VARIOUS METHODS OF LEARNING

	Instructed		Uninstructed	
	U	X	U	X
Count (or verbal)	56%	60	40	52
Count and motor	8		5	5
Count: motor secondary	20	20	25	20
Motor	4	12	30	10
Motor: count secondary	12			
Visual: count secondary		4		

2. When the results are analyzed according to methods used by the subjects in learning, we find a bi-modal distribution in the scores. In the uninstructed group, there was considerable overlapping between individuals who used a counting procedure and those who used a motor or mixed attack. Among the instructed subjects, all the motor learners are at the bottom, and we see that almost all of those who learned in better than median time used the verbal method.

3. The proportion of those who used the counting method was somewhat greater in the instructed group, and this method also was put into operation at an earlier stage in the learning process. The naive group, those who learned by purely verbal methods, usually wasted a few trials before application of a systematic procedure,

while many of the experimental group started to count on their first trial. This is shown by the fact that just ten per cent of the control group learned in fewer than ten trials, while somewhat more than half of the instructed group took nine or fewer attempts to master the pattern

4 This earlier orientation and application of systematic learning is seen also in the learning curves. The error averages for the first five trials for the four groups were as shown in Table 4

TABLE 4
ERROR AVERAGES FOR FIRST FIVE TRIALS

	Instructed		Uninstructed	
	U	X	U	X
1	4.5	4.5	5.0	5.1
2	2.8	2.3	4.1	3.8
3	2.4	1.6	3.5	2.9
4	1.9	1.7	3.0	2.6
5	1.8	1.5	2.2	2.1

The very rapid drop following the first trial shows an immediate orientation to the problem Naturally the first trials would produce chance proportions under any circumstances, unless the instructions had included the exact pathways as well as general methods of procedure and comprehensive information about the maze situation in general Most subjects in the uninstructed group show no improvement for a number of trials; the figures do come down, but this slight initial drop is due to a few subjects making rapid improvement, not to the majority of the group, as is the case with the instructed group.

5 Relations with intelligence. Practically all our subjects had taken the American Council Test at the time of University entrance, so their percentile scores could be compared with maze performances. The correlations with total time consumed in learning, which score has been shown (1) to furnish the highest correlations with intelligence, were + 15 and + 24 for the U and X mazes respectively These compare with + 43 and + 63 for the same mazes when the subjects were not instructed as to the best procedures for learning.

Inspection of the scatter diagrams and of individuals' cases reveals two facts. First, the lowered correlations would suggest that instruction makes the groups become more homogeneous in performance than when each subject is allowed to discover his own way of learning. Second, it appears that the brighter individuals did not seem to have profited any more from the class lecture than did those lower in the distribution In fact it may have been that the poorer students actually gained more, especially inasmuch as the more rapid learners do not have such great possibility for improvement This observation is of particular interest with respect to one definition of intelligence, namely that it involves the capacity to profit from experience It is impossible, however, to prove such a theory, as speed of learning has always correlated so poorly with other factors that one could not attempt to predict with what speed any individual might have learned without the instructions

If the writer might be permitted one observation, which may be open to criticism, he may point out that certain personality traits went much more closely with maze performance than did abstract ability. In a rather small laboratory class, which is conducted throughout a whole school year, the instructor gets to know the students very well personally. He observed that those who did well in maze learning were those who were careful, regular, and cooperative, while most of those who did poorly could be classed as careless and lackadaisical about the regular class work, regardless of true ability. This might suggest that those who are not of the highest ability might do very creditably in their daily work with the use of efficient methods.

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L'INFLUENCE DES CONNAISSANCES ET DES INSTRUCTIONS SUR LE RENDEMENT DANS LE LABYRINTHE

(Résumé)

La plupart des expériences sur l'apprentissage, surtout celles sur l'apprentissage du labyrinthe, ont commencé quand le sujet n'a possédé presque nulles connaissances de la tâche ni de l'appareil. On lui fait découvrir sa propre méthode de résolution selon la méthode essai-erreur

Dans des articles antérieurs l'auteur a montré que la méthode verbale ou méthode de compter est de beaucoup la plus efficace, tandis que l'attaque motrice ou kinesthésique et de très peu de valeur. On a donné à une classe d'environ cinquante etudiants des instructions très complètes sur les meilleures méthodes de l'apprentissage, et on leur a expliqué l'appareil aussi en grand détail On compare les résultats à ceux d'un groupe de contrôle, qui a appris de la manière ordinaire sans instructions Le groupe instruit a appris beaucoup plus rapidement dans les épreuves, le temps, et les erreurs Beaucoup plus ont employé la méthode verbale, bien qu'on ne leur ait pas dit absolument de le faire Il n'y a eu aucune relation entre l'intelligence et le profit tiré renseignements donnés dans le cas d'un individu

HUSBAND

DER EINFLUSS DER AUSKUNFT UND DER VORSCHRIFTEN AUF DIE LEISTUNG IM LABYRINTH

(Referat)

Die meisten Versuche über das Lernen, besonders beim Labyrinthlernen, sind davon ausgegangen, dass die Versuchsperson im Besitz keiner Auskunft über die Aufgabe oder den Apparat ist. Sie muss ihre eigne Methode zur Lösung durch Versuch und Irrtum entdecken

In vorangehenden Abhandlungen hat der Autor gezeigt, dass die Verbal- oder Zahlmethode bei weitem die wirksamste ist, während die Motor- oder kinästhetische Methode sehr schlecht ist Eine Gruppe von ungefähr fünzig Studenten erhielte sehr vollständige Vorschriften über die beste Methode zum Lernen, und auch über den Apparat in allen Einzelheiten Die Ergebnisse wurden mit einer Kontrollgruppe verglichen, die auf die gewöhnliche Weise und ohne Auskunft Lernte Die belehrte Gruppe lernte weit schneller bezüglich Proben, Zeit, und Irrtümer. Viele gebrauchten die Verbalmethode, obgleich sie ihnen nicht ausdrücklich vorgeschrieben war Es gab kein Verhältnis zwischen Intelligenz und dem Sachverhalt, ob das Individuum Nutzen aus der Auskunft gezogen hat.

HUSBAND

SHORT ARTICLES AND NOTES

TWO OPERATIVE PROCEDURES FOR ELIMINATING HEARING IN THE RAT

C. W BROWN, M E FOLDESY, AND F M. HENRY

In an attempt to study the sensory cues involved in the relearning of a maze by rats, it became desirable to prevent by surgical procedures the possible utilization of cues from several modalities of sense. The results from studies in which control of sensory stimulation has been attempted by changes in the external maze environment have left the issues in a controversial state Several possible reasons may be offered to explain this state of affairs, not the least significant being the fact that it is extremely difficult through anthropomorphic suppositions to know with certainty when a given type of sensory cue is not systematically affecting the rat. With adequate post mortem checks the surgical method does offer a means for entirely eliminating the effects of several types of sensory stimulation.

Previous studies have indicated that auditory cues are not essential to the learning or relearning of the maze. To the writers' knowledge, however, no experiment has been reported in which total and permanent deafness has been produced. Most investigators, following the lead of Watson (3), have been content to dislodge the ear bones by probing, then to plug up the middle ear with gum, wax, paraffin, or some other substance and await results With the passage of time, from four to seven days, the rats' hearing has returned and the experimenter has been forced to qualify his discussion with the statement that the animals were only partially deaf

It is very difficult to immobilize the membranes of the middle ear by the infiltration of a substance in liquid form which becomes solid upon cooling to the temperature of this region, the initial temperature of the substance being kept within the range which will not be too destructive of the tissues[1] In order to get to the oval window the infiltrate must not only be fluid but must not cool too quickly upon contact with the tissues of the middle ear. Because of the relatively inaccessible position of the oval window, and because of the difficulty of expelling all the air from the region about the stapes, it is almost impossible to get the substance into intimate contact with the membrane before it is cooled Even after the infiltrate has been successfully introduced and allowed to harden, it is still subject to dislodgement from the membrane by the movements of the head and especially the ears of the animal and from fluid exudates resulting from tissue irritation Consequent movement of the solid mass is probably the cause of the return of hearing after an apparently successful operation has been performed.

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[1] Hughson and Crowe (1) found a reduction in the Wever-Bray effect for tones of low frequency from fixation or division of the ossicular chain, and an even greater decrease in the intensity of the effect from puncture of the round window. However, it is doubtful whether the experimenters separated the Wever-Bray effect from the action currents arising in the cochlea. (See Kreezer, 2)

There are three methods for successfully eliminating auditory sensations: (*a*) severance of the auditory nerve, (*b*) destruction of the cochlea, and (*c*) prevention of the normal movements of the fluids in the cochlea The first method cannot be executed with sufficient success in the rat to merit its use

Method *b*, destruction of the cochlea, is not a difficult operation This organ is located in the inner ear just caudal and dorsal to the lumen of the external auditory meatus By introducing a straight probe at an angle slightly upward and backward of the meatus it is possible to break through the large part of the bony labyrinth and disrupt the basilar membrane and its associated structures Manipulating the probe in the middle ear, of course, destroys the relation of the three ear bones Complete deafness is not produced unless a sufficient amount of the cochlear contents is disturbed to put out of function the entire length of the basilar membrane This is best accomplished by destroying a considerable portion of the base of the cochlea, thus making the opening into the bone large enough to allow the fluid contents to drain into the middle ear

Using the foregoing method we have been able to produce deafness in rats for five tones varying in pitch from 3000 to 5000 cycles with intensities between seventy and eighty decibels above the human threshold, for sounds emitted by an ordinary buzzer, and for noises produced by the rattling of stiff paper. The familiar pinna reflex to sound was used as the criterion for hearing[2] It is a well-known fact that a rat which appears to possess normal hearing will usually respond with a twitch of the ear to various kinds of sounds[3] In a preliminary test before the operation the auditory acuity of each rat was tested for different sounds Every rat gave the pinna reflex to all sounds Individual differences in acuity were noted After recovery from the operation systematic tests were made over a period of three weeks and a final test at the end of two months Complete deafness for all sounds used was produced by this method Post mortem examination of three rats, which were sacrificed at the end of three weeks, revealed that each cochlea was about two-thirds demolished. The stapes was severed from the incus and dislodged from its normal position The bony labyrinth around both the oval and round windows was destroyed.

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[2] An investigation by Henry and Foldesy is now in progress to determine the validity of the pinna reflex as an index of auditory acuity in the rat

[3] Dispute has arisen as to whether rats react to pure tones In their experiment Henry and Foldesy definitely have proved that rats do respond to pure tones They have found the threshold for the pinna reflex to be higher than the threshold for other types of response

Two limitations of the method should be noted First, it is not always possible to tell just when enough of the cochlea is destroyed. However, if upon recovery hearing returns, a second operation can be made without undue shock to the animal Secondly, during the actual probing of the bone there is a risk of piercing the dorsal root of the internal carotid artery which extends along the ventral edge of the labyrinth, thus causing hemorrhage This does not prejudice the success of the operation and if the hemorrhage is checked properly will not seriously influence the animal's chances to recover Temporary disturbances in equilibrium occasionally arise but they disappear after a few hours.

In method C no mechanical destruction of the bony labyrinth is required The two membranous windows of the inner ear are rendered nonfunctional by introducing a solution of sulphuric acid into the middle ear The usual procedure is to pierce the tympanic membrane and disrupt the ear bones by means of a probe inserted through the external auditory meatus, care being exercised not to rupture the carotid artery A 10 per cent solution of the acid is then introduced by means of a hypodermic syringe The needle is inserted at a slightly backward and upward angle and allowed to contact the bony labyrinth before the acid is discharged. Under these conditions the acid is released at a point in close proximity to the two membranes The acid is left in the middle ear for from three to three and one-half minutes at which time pledgets of cotton are introduced to absorb it. The middle ear is then irrigated a number of times with sodium bicarbonate to neutralize any remaining trace of acid

A group of rats were operated upon in the manner just described, after tests of their acuity for both tones and noises had been made Recovery from the operation was immediate in all cases Systematic tests over a period of two weeks and a final test at the end of two months revealed a complete deafness to all the sounds used Two animals were sacrificed after six weeks and an examination made of the inner ear In each case the bony labyrinth of the cochlea was undisturbed. The stapes was still fastened to the oval window, considerable force being required to detach it When viewed under magnification the membrane of the round window was seen to be loosely stretched across the opening. Forced movements of the stapes by means of a probe indicated that the oval membrane no longer manifested the tension and elasticity that is characteristic of it when examined under non-acid conditions. Puncture of both windows resulted in an exudation of a viscous syrupy fluid, probably the perilymph This would indicate that the contents of the cochlea had not been seriously disturbed[4]

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[4] Two rats operated on by method C showed vestibular disturbances about three weeks after the operation apparently as a result of infection.

This third method is to be recommended as superior to the procedure requiring the destruction of the cochlea on two counts: the frequency of hemorrhage and disturbances in equilibration is not as high, and the subsequent shock effects seem to be considerably less. In this operation certain precautions should be exercised The ear should be thoroughly irrigated with an antiseptic solution, such as hexyl-resorcinol, before probing and after the neutralization Further precaution against the development of infection should be taken during the recovery period In no instance should a solution be introduced into the middle ear under pressure. Under such conditions the fluid is forced through the eustachian tube to the nasopharynx, from which it may enter the nasal passages, irritating the mucous membrane, the trachea and associated structures with the possibility of the development of aspiration pneumonia. This danger is materially lessened if between solutions pledgets of cotton are introduced into the middle ear to absorb any liquid present This step should always precede the introduction of the acid as it decreases the chances that the acid will be prevented from contacting the membranes because of the presence of the antiseptic

As no incisions in the external ear are required, either of the methods herein described is faster than the former method of infiltration of paraffin. Fifteen minutes is sufficient for a double operation on one animal Much of this time is spent in making the concha and external meatus aseptic Because of the rat's susceptibility to infections of the inner ear, precautions of this sort are amply repaid To date, two mortalities have occurred in forty rats subjected to operations in both ears They resulted from inflammation of the mucous membrane and trachea following the entrance of the acid into the nasopharynx

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PROFESSOR L S VYGOTSKY (1896-1934)

A R LURIA

The scientific world of the Soviet Union has lately lost one of its brilliant men. Professor L. S Vygotsky, the most prominent soviet psychologist, died of tubercular complications on June 11, 1934, at the age of 38

Professor Vygotsky held a very high place among soviet psychologists Working in the field of psychology, paedology, defectology, and in the clinics, he gained a leading position in all those fields, having shown himself as an innovator and having created a new school with a large number of followers all over the country In his early years in Gomel (his native town) and afterwards in Moscow Vygotsky devoted himself to the study of psychology He realised that the present state of psychology allowed no satisfactory scientific explanation of human personality and those complex regularities of the life of the human brain which are specific human qualities The subject of his work, therefore, was the creation of the *psychology of man,* the science of the complex laws of the human psyche In his early works Vygotsky laid stress upon the fact that psychology was in a critical state, having been divided into two isolated branches. One of those branches approached human psychology from the naturalistic point of view and, having applied physiological methods, was in a position to explain only the most simple phenomena, leaving the more complex features of human consciousness without any scientific explanation On the other hand, idealistic psychology, studying those complex forms of human consciousness considered them to be the product of the spirit and, refraining from any explanations, excluded psychology from the field of natural sciences.

Professor Vygotsky aimed at *explaining historically the developing of consciousness* and the origin of the most complex elements of the human psyche, thus turning psychology into a science which would be able to explain the highest human functions In order to explain scientifically the origin and functions of the complex forms of human consciousness, Vygotsky began to study its development, and modern science is indebted to him for his work on the *genesis of the psychological functions of the child.* He established that the determining factor in the psychological development of the child and in the creation of the complex mechanisms of the psyche is the *social development of the child* His experiments led him to the conclusion that the child during his educational period and in a real contact with the world of adults acquires not only new habits, but that *new mechanisms* are formed which are social by their nature and are the *forms of relation between the child and the adult which become, during the time of the development of the child, its own forms of behavior,* mechanisms of the organization of the psychological process. In a number of papers on his experiments, which have now become classical in Russian psychology, he described some of those mechanisms, social by *nature* and indirect by their structure. He showed that the development of the psychological functions of the child is bound up with a deep change in the mind, with the development of new and intricate relations between the psychical functions, and with the genesis of *new functional systems* In the light of that theory Vygotsky analysed the origin of such complex psychological functions as logical memory, active attention, will, speech, thought, and character, being the first psychologist to introduce the historical method in the experimental study of these important problems of human activity

Professor Vygotsky's attention was drawn by the fact that *speech* plays the most important role in the development of complex behavior, it is speech that allows the creation of new functions, connected by their meanings His further work was devoted to the study of the *development of the meaning of speech* He proved that *the meaning of a word does not remain constant* with the child and that, in connection with the development of the meaning of speech, the correlation of the physical processes are developed and new psychical functions are formed, which are the specific features of the mind of man Having begun with the development of the mental functions, Vygotsky worked out his theory about the *meaningful construction of human consciousness, taken as the product of the historical development of the mental functions* The work of Professor Vygotsky was not confined only to purely theoretical problems His researches exercised considerable influence upon the practical application of psychology The weakness of classical psychology lies in the fact that it did not influence the practical sphere of life The outstanding problems of pedagogics and medicine received little help from either physiological psychology or idealistic (*geisteswissenschaftliche*) psychology Vygotsky was able to approach scientifically the burning problems of every-day life. He carried out a number of researches which are of great pedagogical importance His associates showed *how the children understand the ideas they get at school, how the development of the child affects its training and is stimulated by the training* His laboratory work allowed him *to predict the development of the child and to define its scope* The work which he carried out in the Institute of Experimental Defectology in Moscow showed how the study of the development of the mental process could be laid as a foundation for the organization of the diagnostic and educational work with the child

His contributions to the psychiatric and nervous clinics have been very original He has shown that the study of the disintegration of the complex psychical functions could play an important role in the understanding of the mechanisms of nervous and mental diseases In his work on the psychology of schizophrenia and aphasia which he carried out in the Institute of Experimental Medicine he gave brilliant examples of the psychological solution of clinical problems His posthumous paper to the Psychoneurological Congress deals with the problem of *localization of the mental functions in the cortex*

We have lost a scholar who has defined the path for the development of soviet psychology, paedology, and defectology. His pupils are now working in different laboratories of Moscow, Leningrad, and Kharkov. He has left a considerable number of books among which *Paedology of school age, Paedology of the youth* and *Thought and speech* are the most important His important philosophical work *The theory of affects by Spinoza—Prolegomena to the psychology of man,* which sums up his activity in the field of psychology, is yet to be published.

We have lost a man who has been closely connected with soviet public life and whose manifold activities have defined to a considerable extent the ways by which scientific work will be carried on at schools and subsidary institutions

We have lost a man whose great intellect and personal charm will be ever remembered by those who happened to come in contact with him

IMPORTANT WORKS OF VYGOTSKY

1 Pedagogical psychology (Russian) Moscow, 1926.
2 Paedology of school age (Russian) Moscow, 1928.
3 Paedology of the juvenile (Russian) Moscow, 1931
4. The principles of paedology (Lectures in Russian) Moscow, 1934.
5 Thought and speech (Russian) Moscow, 1934
6. The meaning of the present psychological crisis (In print).
7 Spinoza and his theory of affection—Prolegomena to the psychology of man (In print)
8 The problem of the cultural development of the child. *J Genet. Psychol.,* 1930
9 Thought in schizophrenia. *Arch Neur. & Psychiat,* 1934

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SOCIAL STATUS AND VOCABULARY*

NOEL B CUFF

I INTRODUCTION

There are numerous indications in the relevant literature that a marked relationship exists between the social status of the family and the child's vocabulary development Degerando, for example, as early as 1847, concluded that the child of the rich understands more words than the child of the poor Lombroso also reported that fifty children of well-to-do families had much larger vocabularies than one hundred children from poor families. Recent experimental studies have led likewise to such conclusions as these (1) There is a cyclical relationship between the periods of rapid increase in vocabulary and the widening of the child's experience (2) Children of the upper class are about eight months ahead of children of the proletariat in language development (3) Children of well-to-do and educated families exceed those of the poor both in the precocity with which they interpret words and in the exactness reached in the proportion of 2 1 (4) Environmental factors correlate consistently higher with the results of vocabulary tests than with intelligence test results

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*Read at the twenty-first Annual Meeting of the Kentucky Academy of Science, Berea, Kentucky, 1934.

In view of such critical or uncritical conclusions, we have tried from brief explorations to determine· first, whether significant positive relationships exist between vocabulary development and social status and, second, whether some social vectors are better indexes to vocabulary development than are others.

II INVESTIGATION

The method of study in this investigation involved the securing of the following data for 258 children, recruited from grades four to twelve of the Eastern Kentucky State Teachers College, Training School First, an attempt was made to secure measures of social status by asking the children to answer the questions that are included in Table 2, and by using a scoring technique similar to that used by Sims Then an effort was made to determine active or free association vocabularies by furnishing the children with prepared blanks and by giving them these instructions.

> Now I want to see how many different words you can write in 15 minutes When I say GO, you must begin and write the words as fast as you can, and remember that just any word will do, like clouds, dog, chair, happy and so on But you must not count or write sentences. Ready GO

At the end of 5 minutes and at the end of 10 minutes the children also were told

> STOP, skip one row, GO

The scores were the number of different words written by a given child during the allotted cumulative intervals—namely 5, 10, and 15 minutes

Table 1 shows the correlation between social status and free association vocabulary scores for the respective grades It is obvious the correlation shown in Table 1 for social status and the number of words written in an interval of 5 minutes by fourth grade children is 21 Likewise it is apparent that the median of the *r*'s for social status and the active 5-minute

TABLE 1

CORRELATIONS BETWEEN SOCIAL STATUS AND FREE ASSOCIATION VOCABULARY SCORES

Vocabulary					Social status					Med
	4	5	6	7	8	9	10	11	12	r
5 minutes	21	.34	28	30	01	36	38	13	30	30
10 minutes	29	31	30	42	21	28	23	32	28	29
15 minutes	32	.33	34	.46	.10	27	17	29	36	32

vocabularies of grades 4 to 12 inclusive is 30; and that the medians of the r's for social status and the 10-minute and the 15-minute vocabularies are respectively 29 and 32.

While the 30 correlations in Table 1 do not give a decisive answer to our categorical question, What is the relationship between social status and active vocabulary? they do focus a sidelight of definite suggestion upon the problem Since all of the correlations are positive the conclusion may be drawn that an affirmable relationship exists between social status and vocabulary But, on the other hand, the fact that the correlations are small makes it unwise to state unqualified generalizations The magnitude and reliability of the measures of relationship certainly do not justify drawing uncritically the corollary that vocabulary is largely due to social status The correlations, with their limitations, merely tend to show that a positive relationship exists between the two variables—social status and vocabulary

The results in Table 2 are presented in an attempt to answer partially the question, What social vectors, if any, are the best indexes to vocabulary development? The findings presented in this table were derived by the following procedures. The social status question lists were examined to determine the percentage of the children in the upper and lower fourths on vocabulary scores for grades four to twelve respectively who possessed each item in the question list The difference between the percentage of children in the high fourth on vocabulary and the low fourth on vocabulary in a given grade possessing each specific item was found The respective questions were then ranked for a given grade on the basis of these differences. After the questions had been ranked for each of the nine grades, the ranks for the particular questions were combined and the sums of these ranks were then used to determine the ranks shown in Table 2 For example, question 1 ranks 3 for grade four, 16 for grade five, 27 for grade six, 17 for grade seven, 7 5 for grade eight, and so on When these ranks are added and the question is ranked on the basis of the sum, it is evident from Table 2 that the possession of a telephone ranks 22 in a list of 29 questions. It is also apparent from the ranks given in this table that question 9—Does your mother regularly attend lectures?—is the best index to

TABLE 2

COMPARATIVE VALUES OF SOCIAL VECTORS AS INDEXES OF ACTIVE VOCABULARY

No	Question	Rank
1	Have you a telephone in your home?	22
2	Is your home heated by a furnace in the basement?	4
3	Do you have a bathroom that is used by your family alone?	12
4.	Do you have a bank account in your own name?	6
5	Did your father go to college?	14
6	Did your mother go to college?	10
7	Did your father go to high school?	16
8	Did your mother go to high school?	5
9	Does your mother (or the lady of the home in which you live) regularly attend any lecture courses of which you know?	1
10	Do you have your own room in which to study?	26
11	Do you take private lessons in music?	9
12	Do you take private lessons in dancing?	7
13	Does your mother belong to any clubs or organizations of which you know?	3
14	Do you belong to any organizations where you have to pay dues?	2
15	Does your family attend concerts?	12
16	Where do you regularly spend your summers?	23
17	How often do you have dental work done?	27
18	How many servants, such as a cook, a housekeeper, a chauffeur, or a maid, do you have in your home?	20
19	Does your family own an auto which is not a truck?	17
20	How many magazines are regularly taken in your home?	20
21	About how many books are in your home?	11
22	How many rooms does your family occupy? How many persons occupy these rooms?	14
23	Write your father's occupation on this line	24
24	Is a daily newspaper regularly taken in your home?	8
25	Does your family own a piano?	29
26	Does your family own a radio?	28
27	Does your family own a victrola?	25
28	Do you usually see at least one movie each week?	18
29	Do you generally see at least one movie each month?	19

vocabulary, that question 14—Do you belong to clubs?—ranks 2, that question 13 ranks 3, that question 2 ranks 4, and so on. The ranks in Table 2 may suggest that lectures attended by mother, child's clubs, mother's clubs, furnace, mother's high school, bank account, dancing lessons, daily newspaper, music lessons, and mother's college are the ten social factors or vector quantities having most to do with determining the size of one's active vocabulary.

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APPARATUS

AN ARRANGEMENT OF TYPE FOR A TEN-KEY TYPEWRITER[1]

Marie L H Forbes

The purpose of the note is to describe an arrangement of type for a ten-key typewriter

From a three-bank typewriter two rows of keys were removed and the shift keys were operated by pedals connected with them by wires as shown in the photograph In the type-faces the following substitutions were made

A S D F G H J K L for q w e r t y u i o p
Z X C V B N M for 1 2 3 4 5 6 7

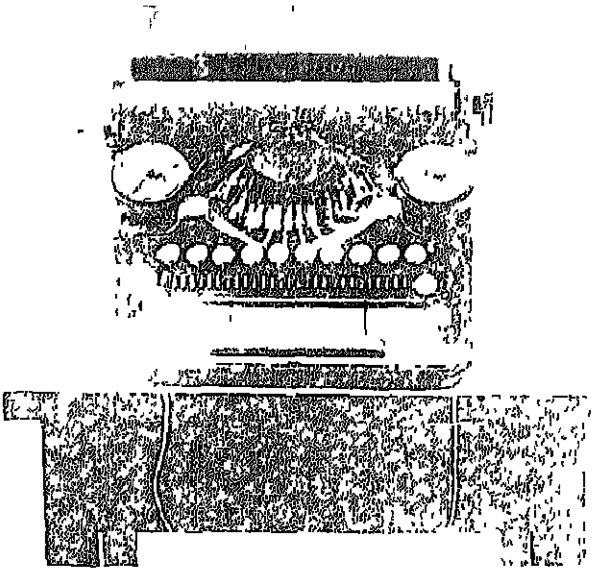

FIGURE 1

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[1] The writer acknowledges examination of specifications and photographs by her former instructor, Walter F Dearborn, M D, Director of the Psycho-educational Clinic of Harvard University

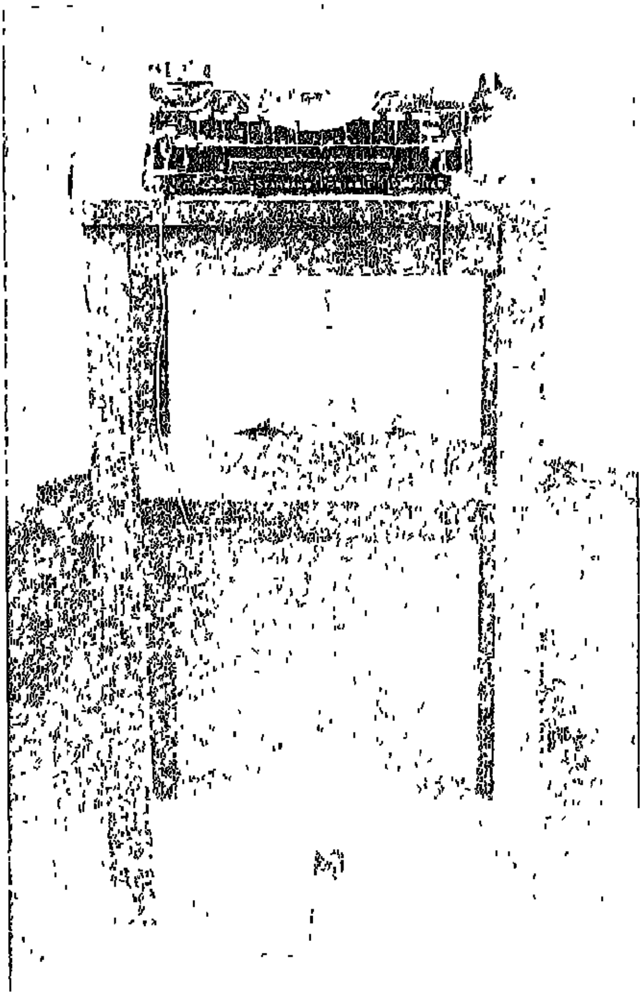

FIGURE 2

8½ Ish Place
Cambridge, Mass

AN ARRANGEMENT OF ALPHABET-INSETS[1]

Marie L H Forbes

The purpose of the note is to describe an arrangement of wooden letters and stencils.

Wooden letters are piled three-deep in round boxes in typewriter order and a word-stencil of wood or cardboard is placed opposite the center of the group of letters. A cardboard shield is moved from left to right across the stencil as the filling of the letter-holes progresses.

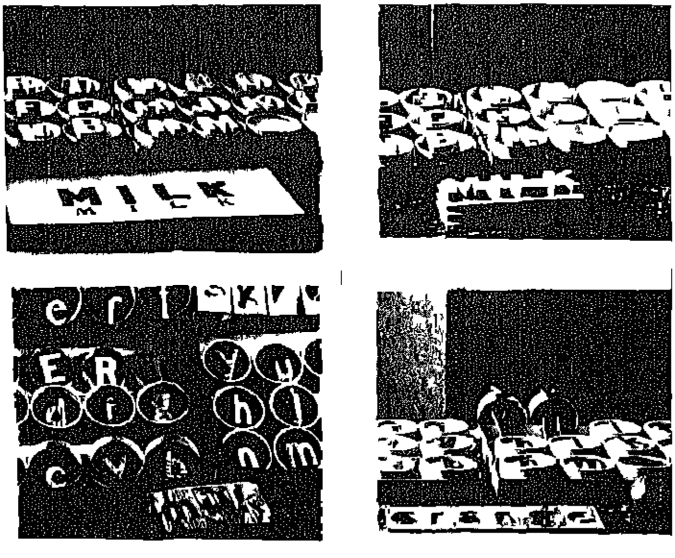

FIGURE 1

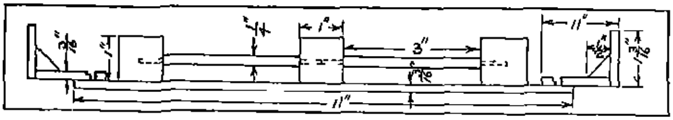

FIGURE 2

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[1] The writer acknowledges the examination of the photographs by her former instructor, Walter F Dearborn, M D, Director of the Psycho-Educational Clinic of Harvard University.

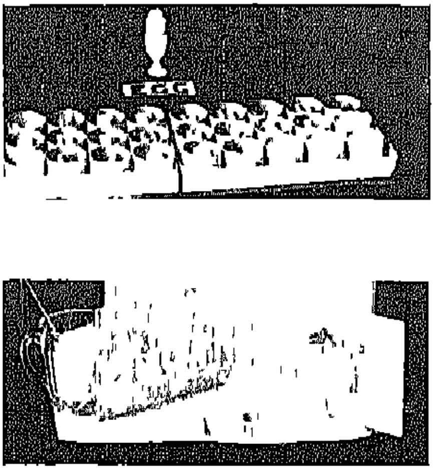

FIGURE 3

AN ARRANGEMENT OF PRINTING-CUBES WITH COMBINED INK-PAD AND TYPE-CELL ERRATUM

MARY L. H. FORBES

An error was made in the sequence of the letters printed in the second half of the groupings on page 437 of the article in this journal, volume **44**, 1934 The correct sequence should be

e t a i s   o n h r d
l u c m f   w y p g b
v k j q x   z

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BOOKS

C MURCHISON [Ed] *A Handbook of General Experimental Psychology* Worcester, Mass Clark University Press, 1934 Pp xii+1125

This volume is largely a revision of *The Foundations of Experimental Psychology* published in 1929, and reviewed by the present writer in *The Journal of General Psychology* (1930, **3**, 344) In revising the 1929 volume it was decided to publish three "handbooks" The first of these, on Child Psychology, has already appeared This is the second, and the third, which will complete the enterprise, is to be *A Handbook of Social Psychology*

The book before us omits eight of the chapters in the first volume, and is divided in two parts called "Adjustive Processes" and "Receptive Processes" There are now twenty chapters in place of the fifteen which covered these topics in the earlier book Thirteen of these are revisions of previously published chapters written by W J Crozier, T H Morgan, Alexander Forbes, W B Cannon, Philip Bard, Carney Landis, K S Lashley, Walter S Hunter, the late L T Troland, Selig Hecht, H Banister, and H Hartridge "The Labyrinthine and Postural Mechanisms" by J G Dusser de Barenne replaces the previous chapter entitled "Space and the Non-auditory Labyrinth" by J Q Holsopple, and the chapter on "The Sense of Feeling" by J P Nafe is now replaced by a chapter on "The Pressure, Pain, and Temperature Senses" by the same writer

The five new chapters are as follows "Learning I The Factor of Maturation," by Calvin P Stone, "Learning II The Factor of the Conditioned Reflex," by Clark L Hull, "Work of the Integrated Organism," by Edward S Robinson, "Vision III Some Neural Correlations," by C H Graham, and "Audition III The Physiological Phenomena of Audition," by Hallowell Davis

All the previously published chapters have been changed more or less The most extensive expansion occurs in Selig Hecht's chapter on "The Nature of the Photo-receptor Process," which has more than doubled its size In the main, changes consist in bringing the articles up to date with references to recent publications and the discussion of new points of view W J Crozier's "The Study of Living Organisms" reappears with revisions under the joint authorship of Crozier and Hudson Hoagland H Hartridge now appears as sole author of the chapter on "Theories of Hearing," for which H Banister was jointly responsible in the previous edition "The Chemical Senses," first written by G. H. Parker and W J Crozier, now appears as a chapter on "Chemoreception" by W J Crozier, although the changes are not numerous

In my previous review of this work, I pointed out that the subject of experimental psychology seemed to have reduced itself to biology and statistics Statistics finds no place in this volume, biology has become the sole basis for a "general experimental psychology" It is important to note that the bankruptcy of experimental psychology, to which the previous volume bore evidence, is now complete No one of the new chapters, nor any of the old ones, makes any significant use of psychological as distinct from physiological concepts, and only one-half of the authors are professed psychologists So completely have we passed into the hands of our receivers

While this consummation may occasion dismay in some quarters, a wider view of the prospects of psychology is perhaps more heartening Experimental psychology had its inception in laboratories of physiology It is now returning to its former home for inspiration and technical aid The return should cure much of the naive reliance which has sometimes been placed in outmoded concepts of physiology and neurology Though we still lack the critical insight to deal adequately with the epistemological problem which must continue to hover about the foundations of any science, and especially a science of psychology, a knowledge of behavior, which the precise studies recorded in this volume do much to promote, cannot but lead to a systematic psychology which in due course will take its rightful place among the more exact sciences

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$7.00 per volume
Single numbers $4.00

QUARTERLY
Two volumes per year

June, 1935
Volume XLVI, No. 2

Founded by G. Stanley Hall in 1891

THE PEDAGOGICAL SEMINARY AND
JOURNAL OF GENETIC PSYCHOL

Child Behavior, Animal Behavior, and Comparative Psychology

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Entered as second-class matter August 3, 1897, at the post-office at
Worcester, Mass., under Act of March 3, 1879

Journal of General Psychology

EDITED BY

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Quarterly, published in January, April, July, and October. Devoted primarily to experimental, theoretical, clinical, and historical psychology. Manuscripts may be sent to any member of the Editorial Board, or may be sent directly to the general editorial office. All subscriptions and business communications should be sent directly to the Clark University Press. Beginning January, 1932, one thousand pages (two volumes) annually. Per annum $14.00; per volume $7.00; single numbers $4.00. Complete sets from 1927 at $7.00 and $8.00 per volume, plus transportation.

The Pedagogical Seminary and

Journal of Genetic Psychology

EDITED BY

CARL MURCHISON, *Clark University*

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Quarterly, published in March, June, September, and December. Devoted to child behavior, animal behavior, and comparative psychology. Manuscripts may be sent to any member of the Editorial Board, or may be sent directly to the general editorial office. All subscriptions and business communications should be sent directly to the Clark University Press. Beginning January, 1932, one thousand pages (two volumes) annually. Per annum $14.00; per volume $7.00; single numbers $4.00. Complete sets from 1891 at $7.00, $8.00, and $10.00 per volume, plus transportation.

CLARK UNIVERSITY PRESS
Worcester, Massachusetts
U. S. A.

$7.00 per volume
Single numbers $4.00

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JUNE, 1935

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CHIMPANZEE TWINS: BEHAVIORAL RELATIONS AND DEVELOPMENT*

From the Laboratories of Comparative Psychobiology, Yale University

Michael I. Tomilin and Robert M. Yerkes

On June 26, 1933, fraternal chimpanzee twins were born at the Anthropoid Experiment Station of Yale University, Orange Park, Florida.[1] Among the nearly two-score chimpanzee births in captivity of which we have knowledge, this is the sole instance of multiple birth, nor have records been found of multiple births in gorilla or orang-outan. These facts do not necessarily indicate lower frequency of multiple births in the anthropoid apes than in man, since recorded anthropoid births in captivity are few and it ordinarily is impossible in nature to distinguish own from adopted infants.

On account of the uniqueness of our observational opportunity it has seemed desirable to report briefly the circumstances of this twin birth, distinctive features of maternal-infant relations and behavior, and significant happenings during the first year of the twins' postnatal existence.

The father of the twins is Pan, No. 2 in the laboratory records. He is tentatively classified by Harold J. Coolidge, Jr., as *Pan vellerosus*. Pan was purchased for Yale University on arrival from West Africa in September, 1925. When the twins were born, he is estimated to have been about eleven years old. He is of medium size and weighs about 46 kg. His coarse coat ranges from dark brown to rusty gray. Always exceptionally healthy and strong, he is also notably vigorous sexually.

The mother is Mona, No. 36 in the records. Mr. Coolidge designates her as *Pan leucoprymnus*. Purchased by Mrs. Rosalia Abreu of Havana, Cuba, at estimated age of three years, she was a member of the Abreu collection of primates for some fifteen years. On May 13, 1931, she was received at the Yale Experiment Station as gift of Mr Pierre S. Abreu "Monona," as she was called in Havana, has been known to Mr. Yerkes since 1924, when he first visited the Abreu estate (8) On the birth of the twins she is estimated to have been about twenty years old She is huge for a chimpanzee female of her species, usually very fat, and in 1933 she weighed from 60 to 70 kg Her coat, like that of Pan, is coarse and ranges from brown to dirty gray

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*Accepted for publication by Carl Murchison of the Editorial Board and received in the Editorial Office, February 19, 1935.

[1] For announcement of this unusual occurrence see Yerkes (9).

Mona is an experienced mother Prior to the birth of the twins she had borne three babies Lita, January 22, 1923, Cuba, March 24, 1926, and Mon, October 27, 1931 On June 6, 1932, she suffered a miscarriage. Menstruation recurred on August 12, 1932. She was placed with Pan for mating on June 21, 1932, and continued to live with him until June 20, 1933, when in anticipation of parturition she was transferred to the maternity building. About seven o'clock on the morning of June 26, it was discovered that during the night she had given birth to twins

From the laboratory records of cyclical oestrous change and vaginal cell counts (observations of O. L. Tinklepaugh), it appears that impregnation occurred sometime between November 25 and December 1 The period of gestation was therefore 210 ± 5 days, or seven and one-half lunar months The condition of the infants at birth suggests prematurity by two to four weeks This is in accord with expectation from human experience in multiple birth.

The gestational period was uneventful Parturition was not observed. The afterbirths had disappeared before the arrival of an observer. Presumably they had been eaten completely by Mona. Some 50 cm of umbilical cord was attached to each infant The following day these cord fragments were discovered in the cage, severed from the chimpanzees

We report this case of chimpanzee birth and development separately instead of as one among several for which data are available, because of features of relationship and behavior which are peculiar to the multiple birth. The literature contains nothing comparable There are indeed few descriptions of newly born chimpanzees (1, 2, 3, 4, 5, 6, 7) The only account of mother-infant relationship and of infant development under maternal care is that of von Allesch.

For purposes of description, Mona and the twins were observed, with few exceptions, daily, and usually several times each day, by

Mr Tomilin, who took entire charge of them, from June 26, 1933, for one calendar year. During this time mother and infants were left together in natural relationship Experimental procedures were not employed, and no measurements were made until the infants were one year old It was our purpose to observe as nearly naturalistically as is possible in case of a captive confined animal.

This report is based primarily upon the content of Mr Tomilin's daily notes Mr Yerkes, in the light of his intimate acquaintance with Pan and Mona for several years, of his observation of mother-infant relations and behavior in approximately a score of cases, and his acquaintance with the anthropoid literature, has supplemented and interpreted the note materials in preparing the manuscript of this report. Both authors have contributed illustrative photographic records

Our subjects were caged alone For the first eleven months they lived in one or other of two compartments (east end or west end) of a maternity-nursery building In the twelfth month they were transferred, because of constructional necessity, to a unit of the main quarters building Their living accommodations always consisted of a heated room in connection with an open-air cage Between the two was a steel slide-door which Mona could operate at will The apartment provided ample space for varied activity and comfortable rest and relaxation Bedding was available in the heated room and there was an abundant supply of fresh air and sunshine

While in the west-end living apartment Mona exhibited at times marked fear of the northwest corner of her cage and persistent avoidance of it This reaction tended to increase from midmorning, was most marked about noon, and then waned In the late afternoon she was sometimes seen sitting in this particular corner The twins were markedly influenced by their mother's nervousness in the cage and clung to her This puzzling avoidance reaction shortly disappeared when Mona, late in the period of observation, was transferred to the east-end living apartment We have no plausible explanation of the behavior, although much thought has been given to the matter.

The diet of the lactating mother for the period of report consisted of fresh fruits (citrus, banana, apple, melon), raw and cooked vegetables (tomato, sweet and white potato, carrot, beet, rutabaga, lettuce, bean), grains (rice, wheat, oats, corn) given usually as hard-baked cracker—"Chimcracker"—or as cooked cereal, milk, eggs, sugar, and salt. For the first six months these foods were given in relatively large quantities, to assure an adequate supply of milk for the two infants. Mona's appetite was excellent and ordinarily she eagerly ate all of the food provided. During the second half of the year the amount of food was gradually reduced, because the mother's-milk diet of the twins was being increasingly supplemented by other food, and also because Mona was tending to become overfat Her maximum weight exceeded 80 kg.

At birth the twins, although seemingly without physical defects, were relatively small, thin, and weak. Possibly this was primarily due to prematurity of birth. Their weight was estimated at 1 to 1½ kg each They were of approximately the same size The skin was dark brown on head and back, somewhat lighter on the ventral surface, and on the face light brown It was light pinkish brown on the palms, fingers, soles, and toes. There was a rather sparse, typically distributed coat of black hair. White hairs occurred only on the upper lip and in a tuft about the anus.

For a fortnight the infants were too weak to cling securely to their mother, even when she was quiescent Change in physical appearance was slight during the first month By the end of the second month several physical changes were obvious Body growth was evident especially in length The coat was thicker and longer; the skin had become somewhat lighter. The eyes had lost the cloudiness of early infancy and were clear, with definite coloration. Tom's brownish and Helene's grayish

For the first six months Helene appeared to be better nourished and if anything larger and heavier than Tom During the sixth month the contrast was very pronounced. This relation was reversed during the second half of the year because Tom took much more readily to supplementary feeding than did his sister and grew very rapidly. At one year of age Tom's weight was 5.88 kg, whereas Helene's was only 4 32 He was obviously larger skeletally than she, and also more fleshy and better developed muscularly Both babies seemed normal in developmental and physical status, as well as healthy and actively adaptive The prevalent skin color was now light brown On the exposed portion of the forehead it was somewhat darker, and there were dark stripes along the sides of the nose which merged with dark brown areas under the eyes The skin of the face was medium brown. The coat of each twin was long, thick, and black Each had long, thick sideboards, heavy black eyebrows, and a small tuft of hairs on the midventral surface of the pinnae. There was no definite longitudinal part on the crown of the head. White hairs appeared at the corners of the mouth and in the ano-genital region.

The sequence of dental eruption was identical in these two infants with that of man, except that the second molars preceded the canines. The latter did not appear during the first year Dental development, as might be anticipated, was more rapid than in man Both Tom and Helene had their eight deciduous incisors before they were six months old The first molars appeared during the succeeding two months, and the second molars in the next three months In time of dental eruption either of the animals might lead, the difference in time in some instances being several weeks For example, the right upper first molar appeared in Helene forty-eight days prior to its appearance in Tom Correlation of dental eruption with general physical growth and development was not apparent

For more detailed description of physical development during the first year of chimpanzee life, based upon varied and frequently repeated measurements, the reader is referred to the report by Jacobsen and Yoshioka (4) Comparable observations obviously would have disrupted our program of naturalistic study of mother-infant relations and behavior

There follows a brief chronological description of certain important features in the behavioral development of the twins during their first year

Obviously successful sucking was observed on the first day for Tom, and not until the fourth day for Helene. Meantime she had become very weak and inactive On the fifth day the twins were seen to suck simultaneously, and from then on they took nourishment regularly and life for some weeks became a routine of eating and sleeping By the second week Mona's supply of milk was so abundant that slight pressure of a nipple might cause it to flow, and at times the rapidity of flow produced gulping or choking in a sucking infant

For five months Tom and Helene lived exclusively on mother's milk In the sixth month interest in solid foods which were given to Mona appeared—first in Tom and shortly in Helene For a time chewing seemed an end in itself, but before the end of the month bits of cracker and other solids were swallowed, after mouthing and chewing. During the third week of this month Tom began to attend to the milk-cereal mixture which was given regularly to Mona, and he repeatedly sought contact with the cup when it was offered to his mother The latter cooperated patiently and effectively with Mr. Tomilin by giving the twin opportunity to try to drink, and in less than a week he was able to do so successfully—his lips over the edge of the cup. Little of the foodstuff was spilled As Helene failed to take the initiative in cup-drinking, efforts were made to teach her They were relatively unsuccessful because she persistently bit into the milk, closed her teeth and lips on the edge of the cup, and spilled instead of swallowing the mixture.

From the seventh month onward Tom took milk-cereal mixture daily, and by the end of the year his intake had increased from a few sips to at least a pint a day. He was able during the second half of the year to eat anything which happened to be given to his mother. He may fairly be characterized as a rapid, hearty eater, whereas Helene has always been a rather light, slow eater, who habitually nibbles and minces Rarely does she eat with gusto, and although she finally mastered cup-drinking, even at one year of age her intake of the milk-cereal mixture was relatively small. Probably her food consumption from the sixth month onward was not more than half that of Tom During the first six months she probably received from her mother quite as much nourishment as did her brother This contrast is the more interesting and question-provoking because Helene clearly led in rapidity of physical growth and development for the first five or six months of postnatal life and fell behind Tom increasingly during the remainder of the year Vigor, health, and normalcy of development were equally obvious in the two infants, but whereas Tom was venturesome, aggressive, quick to adapt and eager to follow up advantages, his sister was relatively timid, shy or backward, slow to adjust to new situations and to profit by successes Does this contrast include the factors which are responsible for the marked disparity in their growth and development?

Clinging to the hair of their mother was the activity in which the newborn infants were most proficient But in this they were discouraged from the first by Mona, who persistently broke their holds upon her whenever she came to rest In the early weeks they were too weak to cling continuously, and as Mona walked about she commonly supported them with one hand and arm as is shown in Figure 2 (p 249) If as she moved about she happened to withdraw the support, they usually sagged toward the floor (see Figure 3, p 250). A common sight during the first fortnight was Mona sitting or lying on the floor of the living room with the babies lying on her legs, abdomen, or on the floor, a picture of helplessness

It is especially noteworthy that clinging to the mother was much more difficult for the twins than it would have been for either of them alone The typical early position of a chimpanzee baby is on the lower surface of the mother's abdomen, ventro-ventrally, in the same orientation as the mother, and with head uppermost, the limbs extended along her sides and the extremities firmly grasping hair, skin, or both The twins could not assume this natural position because of mutual interference. Often one would grasp the other with one or more of its extremities and as a result both would lose their grip on Mona Their difficulties in maintaining holds on their mother were aggravated by her great bulk and the unusual expanse and flabbiness of her abdomen. Ordinarily she did not interfere with their clinging reaction when she was moving about, but almost invariably she tried to free herself from their holds, as if they caused discomfort, as soon as she came to rest

Naturally degree of skill and success in grasping and holding to their mother's coat or skin increased steadily with strength and practice It was only during the first month that embarrassments especially impressed the observers and aroused their sympathy for the struggling infants Sudden disappearance of the clutching reflex was not observed, possibly because of the circumstances which unfavorably affected clinging and tended to complicate its appearance and use

Locomotor activities very gradually replaced random grasping, waving, and weaving movements of the body and limbs First to appear was crawling on the body of the mother. This was during the first month Efforts to crawl or creep on the floor were occasionally observed during the first and second month, but they were unsuccessful because of the smoothness of the surface, and neither of the babies ever developed both tendency and ability to creep about on the asphalt-surfaced concrete floor During the third month of life both infants learned to pull themselves into erect position and even to maintain it while holding to Mona with only one hand.

Thumb-sucking, which was first observed toward the end of the third month, shortly gave place to wire mouthing or chewing. This occurred in conjunction with efforts at climbing, for the twins in attempting to pull themselves up by grasping the two-inch mesh netting of the cage walls discovered that the wire was pleasant to bite and chew at Observational evidence favors the inference that thumb-sucking and wire-chewing were induced by irritation of the gums as dental development proceeded. The latter activity quickly replaced the former because it proved more effective in allaying discomfort and in facilitating eruption of the teeth

From hanging or dangling on the wire netting to climbing was a short step By the end of the fourth month both infants could climb on the cage netting, but only in one direction—straight up They could descend only with Mona's help. At this time, of course, the infants were able to cling to the mother with ease and assurance wherever and whenever they might find opportunity to grasp her. She willingly permitted them to ride about on her, but with much greater eagerness encouraged them to cling to and climb upon the cage netting

It was during the fifth month that the twins shifted their habitual position on the body of their mother Previously both had clung to the abdominal wall whenever it was available and they were permitted to do so. Now Tom by preference rode on Mona's back and Helene clung to an arm or leg. By the end of the month they seldom were seen on her abdomen (see Figures 5 and 6, page —). Although at this time Helene was even stronger than Tom, she was not seen on Mona's back during the fifth month From this it would appear that she preferred the ventral to the dorsal surface of her mother This, perhaps, was conditioned by her timidity.

Although strength and facility in locomotor activities increased rapidly toward the middle of the year, independent walking did not appear until the sixth month Tom was first seen walking, holding with one hand to his mother's side, when he was six months, nine days, old. He was seen to walk alone seven days later. Helene was first seen to walk independently when six months, twenty-one days, old At first both of the infants walked with palms and soles flat on the floor, and it was not until the eighth month that they began to walk as does the adult chimpanzee with the hand closed so that the weight of the body rests on the dorsal surface of the fingers and the knuckles By the end of the eighth month the twins could run about with fair skill and assurance. They finally had achieved, although two or three months later than previous observations justified us in expecting it, mastery of the art of quadrupedal locomotion. It was not until the eleventh month that they learned to walk standing erect and bipedally.

It is scarcely needful to remark that the similarity of chronology indicated above suggests that the behavioral development of the twins was importantly influenced by observation of one another. This inference is supported by many of our observations.

Of exercise and play activities—aside from vague searching, exploring, grasping, and attitude- or position-changing movements—none were observed for several weeks after birth During this time there was much activity which was definitely mother-directed, relatively little which was directed toward a fellow twin or other environmental object.

Creeping, crawling, and climbing as physical exercises appeared as previously described. The acquisition of facility in climbing clearly gave the infants marked satisfaction. Likewise pulling the self into an erect position and maintaining such posture, practiced especially in the third month, proved an engaging form of exercise which clearly was serviceable as preparation for walking

Playfulness, in connection with relations to mother, sibling, and environmental objects, appeared very gradually and in the course of months, as pulling, poking, pommeling, slapping, biting, and mouthing These activities appeared to be ends in themselves, enjoyable, but apparently otherwise goalless Certain forms of them were indulged in increasingly during the second half of the year. It is indeed surprising that the twins were not observed to play together until about the middle of the sixth month, when the following incident occurred. Helene in passing grabbed at Tom and tried to nip him with her teeth. He promptly retaliated in kind! This was on December 6, 1933

By the eighth month, playful activity had become a commonplace to the observer Tom especially engaged quite often in solitary play—swinging, slapping, and acrobatic antics. Occasionally he and Helene were observed playing together, usually either pulling or biting at one another Almost invariably playful activity was initiated by Tom Helene seldom took the lead, and even when her brother tried to start something she commonly in responding gave more attention to maintaining her hold on Mona or other support than to return of Tom's advances From our notes we quote the following as illustrative of this

> February 9, 4 p m Mona is in the middle of her living-room prone on the floor eating crackers. Tom with a small piece of cracker in his mouth walks around Mona, climbs on her back, slides down, walks around her again Helene is sitting beside Mona's right shoulder, holding to it with one hand Tom in walking about comes to Helene and stops, opens his lips slightly, and offers her a piece of cracker which he has in his mouth Helene licks or chews at the bit of cracker Tom withdraws the piece, playfully slaps Helene a few times, walks straight ahead directly over Helene, knocking her down Helene does not respond to his playful advances, she is concentrated on holding to Mona and getting a bite of cracker from Tom She can get a piece for herself by walking about two feet from Mona, but she merely looks toward the piece now and then and does not attempt to get it

From the eighth month to the end of the period of observation, exercise and playful activities increased steadily in variety and amount. Tom, the aggressive, came to play with human acquaintances almost as readily and eagerly as with Helene or Mona. Helene, by contrast, never did so, presumably this was because of shyness, timidity, or both Tom's superior energy, self-assurance, and trustfulness of man gave him a very real advantage over his sister in many respects.

We are able to describe only very imperfectly the form and appearance of vocalizations in case of the twins Birth cries were not heard, because there was no observer present! Whimpering or plaintive crying was common during the early postnatal days in association with physical needs and discomforts A major provocative of this vocalization was Mona's refusal to permit the twins to cling to her undisturbed in accordance with their natural species tendencies.

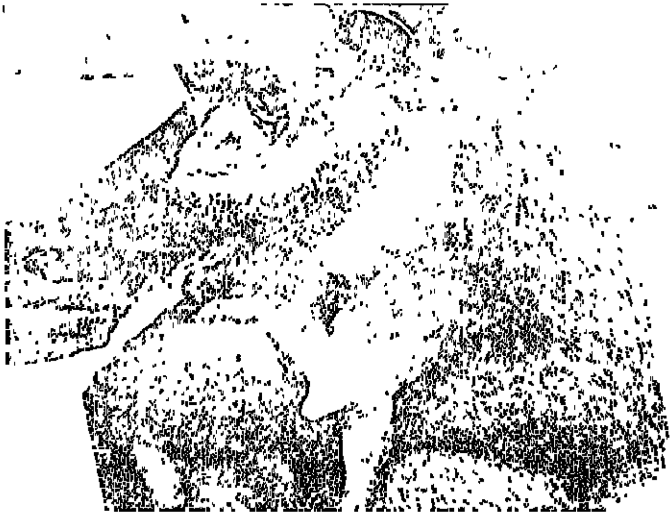

FIGURE 1
The twins on the day after birth, June 27, 1933 The male is covered partially by his mother's huge left arm and hand
Photograph by R. M. Yerkes

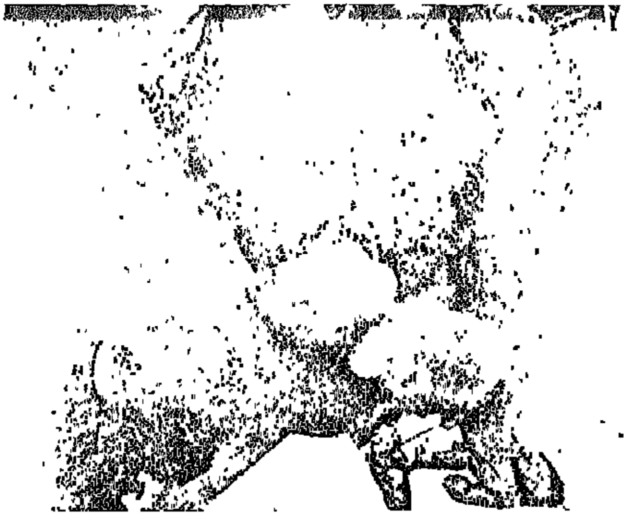

FIGURE 2
On July 22, when twenty-seven days old, the babies still were relatively helpless
[illegible]

FIGURE 3
Even on August 26, age two months, clinging to Mona's abdomen was difficult
Photograph by M. I. Tomilin

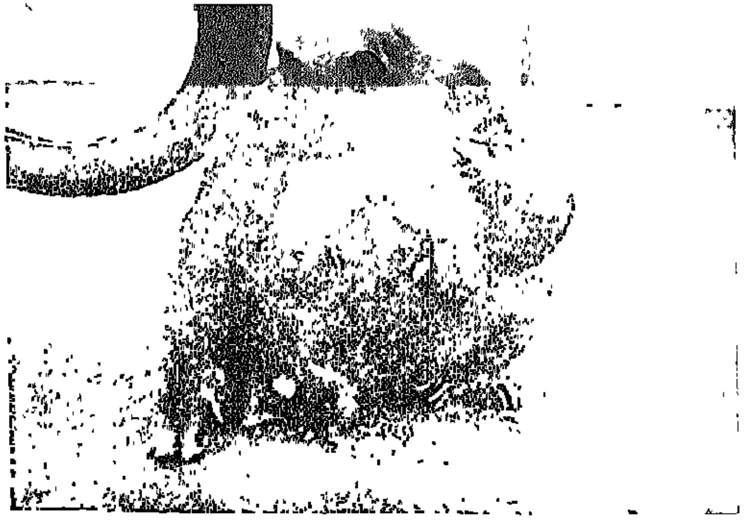

FIGURE 4
The sturdy infants nursing in an uncommon position, at four months, October 22
Photograph by M. I. Tomilin

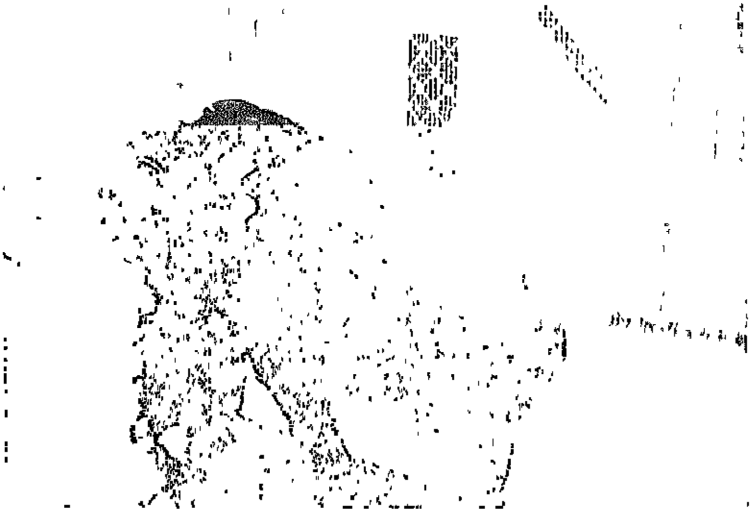

FIGURE 5

Riding——Helene on back, Tom on arm, at six months, one week, of age, January 1, 1934

Photograph by M. I. Tomlin

FIGURE 6

Mona as a common carrier! January 1, 1934

Photograph by M. I. Tomlin

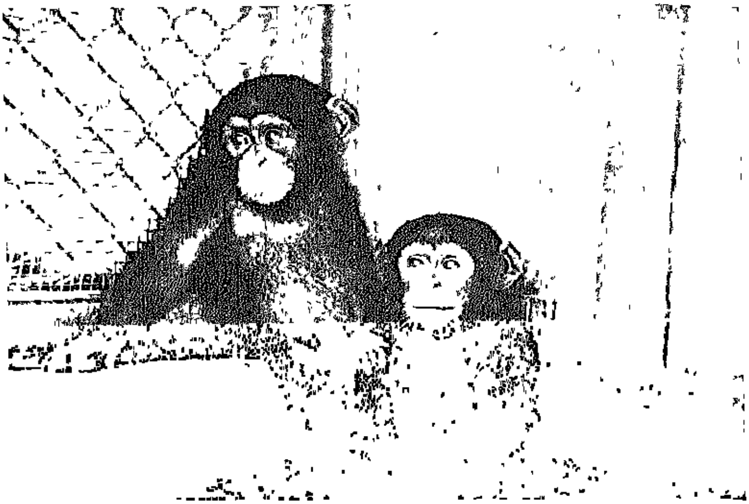

FIGURE 7
Portraits of the twins on their birthday, when one year old, June 26, 1934
Photograph by R M Yerkes

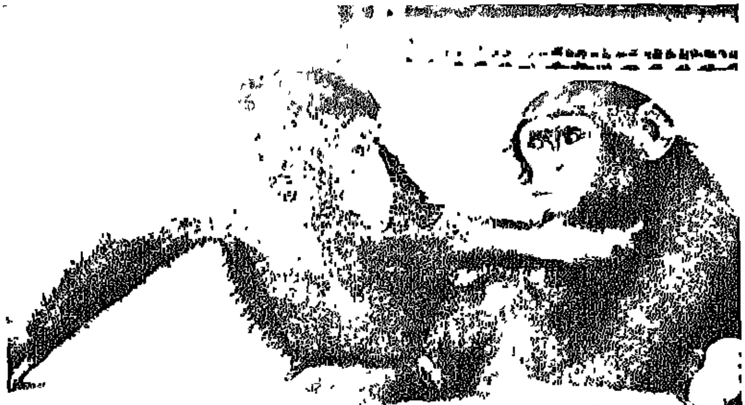

FIGURE 8
Tom responding protectively to vocal complaint by Helene, June 26, 1934
Photograph by R M Yerkes

In the early weeks, as definite expressions of interest, surprise, or greeting, the sounds ŭh-ŭh, and a somewhat more staccato or sharper ah-ah, were heard These continued in use throughout the year, with increasing frequency They may fairly be characterized as significant communicational elements

Whimpering, as the strength of the twins increased, gradually gave place to whining, and that in turn to screaming These varieties of vocalization were more or less definitely mother-directed, and ordinarily they were responded to promptly and serviceably by Mona Especially during the last six months of the year several distinguishable kinds of scream were noted The observer recognized them as different; Mona recognized also their meaning, as, for example, indicative of unsatisfied desire (begging), of apprehension or fear (call for defense), of suffering or injury (call for help), of impatience or protest (appeal for sympathy or attention) Also during the latter half of the period of report, various play vocalizations were exhibited, including murmurs, gurgles, grunts, chuckles. These usually accompanied facial and bodily contortions (smiling, wriggling, jumping) when the infants were manipulating one another's bodies

Our intimately and continuously associated trio exhibited many interesting and to us meaningful or puzzling forms of behavior and social relationship during the period of report. We shall now enumerate and briefly describe what we consider the more important among observed features of mother-infant and infant-infant activities

The attentions of Mona to the twins during their first postnatal hours unfortunately were not observed by us Whether the equivalent of artificial respiration was practiced by the mother to induce breathing, as reported for Mona by Mrs Abreu (8) in case of a previous birth (Lita, January 22, 1923) we do not know The infants were dry and in good order when first seen by Mr Tomilin During the next two days Mona sometimes held or dangled them head downward Although this may have had relation to urination, defecation, or both, the evidence does not in our opinion justify that inference, for the mother may very well have been acting carelessly or unskillfully

From the first Mona appeared to treat the twins with far less concern than is usual in case of a single-birth chimpanzee She gave them the attention necessary to their welfare unostentatiously and almost casually. The observer was made to feel that if not actually bored with her maternal duties she was so far familiar with them that they lacked novelty and neither required nor deserved her constant undivided attention Perhaps this is what experience does to a mother chimpanzee, for whereas Mona has now had five babies, no other female whose maternal relations we have observed has had more than three. We remark the fact of Mona's nonchalantness as mother of twins, because whether an individual peculiarity or a result of maternal experience it is biologically important.

What we have stated above in general terms is exemplified specifically in grooming, for although most chimpanzee mothers groom their own bodies and those of their infants often and thoroughly, Mona very rarely indulged in this activity Nevertheless she and the twins were usually very well groomed. Perhaps this also is primarily economy of effort as result of experience.

An unusual maternal activity[2] which appeared frequently during the early weeks and persisted for several months was infant rocking It was induced usually by restlessness or vocalization of the infant complainingly, and it served generally to soothe and quiet the infant. Mona rocked an infant by holding her hand or forearm against or under its head or body and then moving the arm back and forth rhythmically at different tempos, according to her degree of calmness and patience. Often the activity was continued for several seconds. It clearly was purposeful, and almost invariably it ceased as soon as an infant became quiet.

Much maternal care is necessary to the survival of the chimpanzee infant even in captivity That Mona did not fall short of the requirement made on her by the twins is evidenced by their vigorous health and the course of their development. In the following paragraphs we shall present certain socially significant forms and aspects of the activities associated with feeding and weaning

Early the twins frequently were aided by their mother in finding a nipple, or they were actually placed near or upon the breast, but much more often they groped about until they happened upon a nipple For reasons which are not clear to us, although we suspect that her relative backwardness in sucking was influential, Helene was

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[2] A form of rocking has been described by Allesch (1), and by Mrs Gordon Ireland in unpublished notes in the files of these laboratories, for Mona in case of her previous infant Cubita (Cuba)

Mona's favorite in the early months, and she received, especially in connection with nursing and grooming, noticeably more maternal attention and assistance than did Tom This assuredly was responsible for her relatively more rapid growth in the first six months. Her mother gave her a good start This observation is of psychobiological moment, because, so far as we are informed, mammals which produce more than one young do not discriminate in favor of a weakling or runt and thus further its development Such discriminative attention as was manifest in this case of chimpanzee mother and twins may chance to be peculiar to the primates or to the anthropoid apes and man We raise the question for observational settlement and without intent to prejudice the answer.

After serving as nursing mother for some five or six months, Mona began to manifest desire to be relieved of her charges Increasingly from the sixth month on, and conspicuously from the eighth month, she either discouraged sucking or actually prevented it by keeping the infant from the breast or brushing it off after it had located the nipple Although when this maternal change began to appear the twins were able and willing to take supplementary food, they continued to be eager to suck and often complained persistently when refused opportunity by their mother

One may surmise that it was a case for Mona of too many, too long, or both, and that weary of nursing and otherwise caring for the twins she endeavored to break their nutritional dependence upon her It seems probable that in the functional status of the reproductive system and associated glands we may most hopefully seek the physiological conditions of Mona's progressive disinclination to nurse the twins Whatever the causes or conditions, weaning assuredly was in process and Mona in state of acute conflict because of competing motives

Certain observations suggest the hypothesis that the chimpanzee mother for an appropriate interval prevents her infant from taking supplementary food and thus so regulates demand upon the milk supply as to assure continuance of lactation The hypothesis sounds reasonable, but we lack interpretable observations because it is difficult, without control of environmental circumstances, to distinguish between self-seeking and maternal solicitude Mona often prevented the twins from taking food, but it is by no means clear that she ever did so unless she desired the food for herself During the second half year the twins usually were encouraged by their mother to take supplementary food if at the moment she had an adequate supply or was not hungry. She never hesitated, however, to rob them if she dared and if she desired what they had Naturally the infants learned to safeguard such scraps of food as fell into their hands. Whenever one of them, with a morsel of food in hand, saw Mona attending to it, the food was promptly concealed in the mouth and the infant scurried away to a distant corner.

During the second half-year the twins came to use increasingly a method which they had previously discovered of commanding the co-operation of Mona. It was in effect an appeal to her sympathy. If she refused to let an infant suck, cling to her, take her food, or in short do as it pleased, it would throw itself on the floor and whine or scream. Mona seldom could long resist this infantile appeal Manifestly struggling against conflict, she would go to the infant, take it up, and for a time indulge it Then self-interest having gained dominance, she would once more antagonize the twin and the scene would be repeated Usually the infant won eventually and peace was restored Such sympathy-provoking infantile behavior resulted more frequently from the brushing of a hungry sucking infant from the nipple than from any other maternal act

Sucking was observed rarely in the eleventh and twelfth months At this time both infants were taking a variety of foods in amount sufficient to insure satisfactory growth The process of weaning continued, but so also did lactation, and the inference that even until the end of the year both infants continued to take mother's milk in considerable quantity is supported by the observation that after they were separated from Mona on July 17, 1934, enlargement of her breasts indicated lactation

As already remarked, Mona early interested herself in placing the infants or in helpfully directing their movements in relation to the breasts and nipples. Later she concerned herself also with such infant activities as grasping, crawling, standing, climbing, and walking Although it may not be said that she definitely taught them any of these acts, she manifestly supplied encouragement and aid and thus facilitated acquisition of adaptations. At times it seemed to the observer that in effect she was aiding the infants while by primary intent seeking to rid herself, at least temporarily, of them. When, for example, a twin, holding to his mother, happened in passing to grasp the cage netting, Mona might pause, push the youngster against the wire, and move away Or again she might place an infant on the netting and leaving it hanging there to climb, play, or scream its protest, move away to another part of the cage and ignore the dissatisfied infant Quite obviously she strove to enlarge her freedom by such acts Was she also with intent preparing the infants for independence of her?

It is Mr Tomilin's opinion that until toward the end of the fifth month Tom and Helene did not recognize one another as social objects At any rate, beginning with the sixth month the two, according to observational records, became playmates, whereas previously they had treated one another more nearly as inanimate objects Precisely what psychobiological events led up to mutual recognition and prepared the way for play activities remain to be discovered One is tempted to think of the total process as on one hand the emergence, and on another the discovery, of the self and alter

Without doubt Mona's mysterious fear of one corner of her original cage markedly influenced the attitude and activities of the twins Her apprehensiveness was contagious and the twins were no less inhibited by it than was Mona herself This of course limited freedom of motion, and especially of locomotion. After transfer of the family to new quarters in the same building during the eleventh month, the twins promptly became much more active and independent of their mother, and correspondingly Mona's control of their movements and her attention to them lessened. It was about this time that Helene began to run to Tom instead of to Mona when desiring refuge or protection. This substitution of infant brother for mother prior to completion of weaning or separation is somewhat surprising It was facilitated by the transfer, which in case of Tom as well as Helene accentuated the emancipation of infant from mother

Particularly interesting as aspect of the social situation is Mona's self-interest and her increasingly strong desire to free herself from the twins. That she would have deserted them if in the forest and free to do so seems to us wholly improbable Her behavior suggests rather desire to lessen maternal responsibilities by occasional interruption of contacts with her offspring She always was on hand to protect, defend, or aid them when there was need Whatever the intent, her seemingly selfish behavior served to encourage, when it did not actually compel, the twins to become more self-dependent, self-reliant, and also dependent upon one another. Whether or not one thinks of such maternal behavior as tuition or teaching, it serves the same purpose, and objectively it is difficult to distinguish from what we designate as tuitional in our own lives.

Description of mother-infant relations in this trio would not be safely interpretable, or indeed intelligible, if account of what seems like disciplinary or punitive maternal behavior were omitted. Virtually from the birth of the twins, Mona, in varied and to us wholly unexpected ways, safeguarded her interests and sought either to preserve or increase her freedom of action. This we repeat with emphasis because it is completely at variance with what we have observed in other chimpanzee mothers. When early or late in the period of report Mona desired to be rid of a grasping, clinging, sucking, or begging twin, she used whatever force was necessary to do so. The hold of an extremity might be broken, the infant pushed or brushed aside; it might be shaken, struck, or pushed to the floor, its hands bitten—always gently. Sometimes as the mother thus roughly treated her young she would scream as if in impatience or anger. To us the behavior suggested impotent rage, for the infants usually complained so bitterly that they compelled their mother to relent. She would retrieve the infant, and as she held it to her would vocalize excitedly as if in sympathy with it. Rarely indeed did such maternal treatment result in obvious injury to a twin, and this only near the end of the year. The following incident is exceptional.

> February 8. For the first time in quite a long while a serious misunderstanding between Mona and Tom was observed today. About 10 a. m. Mona was seen shaking Tom as he sought a nipple. Both were screaming. Mona shook, bit, and brushed Tom aside.
>
> At 2 p. m. similar behavior was observed. This time it looked as if Mona did not want Tom to touch her. Tom climbed on his mother's back, she roughly pulled him off, gave him a jerk, and struck him to the floor. He at once tried to get hold of a leg or arm and Mona roughly rid herself of him. The observer entered the cage and Mona at once offered Tom to him. He was accepted and rested quietly in the observer's hands. His nose was scratched and bleeding slightly. Shortly he was placed on Mona's back. She scowled at the observer. He left the room and Mona attacked the door furiously.

Although such maternal behavior eventually may be proved to be common weaning procedure in chimpanzee, this seems to us improbable We are inclined to think that Mona's behavior arises from conflict between primarily selfish interests and desires of the mother and the insistent demands and requirements of the twins The significance of two as contrasted with one infant in such connection has not been determined.

Of the utmost importance in properly evaluating the factual materials of this report are the following facts concerning Mona. With the exception of a few months, all of her life has been spent in captivity. For approximately fifteen years she was the pet of Mrs. Abreu. During this time, as Mr Yerkes hapens to know from conversations with Mrs Abreu and observation of the treatment of the members of her primate collection, Mona was afforded wholly exceptional opportunity to become familiar with man and to adapt to a wide variety of humanly devised situations. For example, she was trained to present objects which chanced to be in hand or cage to Mrs Abreu in exchange for food and to respond to varied gestural or vocal requests and commands of her owner Long ago she lost all fear of man and discovered the practical advantages of cooperating with and outwitting him. She matured in captivity and all of her five babies were born under human surveillance. In case of the first two births, occurring in Havana, human attention, assistance, and interference undoubtedly exceeded those which Mona experienced on arrival of the twins. She is not only an experienced mother, she is also extraordinarily sophisticated as a result of long exposure to a humanly devised and controlled ape habitat and to human companionship She knows and understands man better than any chimpanzee we have ever met!

In the present instance, Mr Tomilin early decided to utilize Mona's docility, experience, and her friendliness toward him as basis for the cultivation of such intimacy with her and her babies as would be advantageous to the conduct of our study. Instead of guarding her infants closely and keeping them upon her abdomen, as the other chimpanzee mothers observed by us had done, Mona even in the early weeks began to offer them to Mr. Tomilin by taking one or other in her hand and pressing it against the cage netting This gesture of confidence, which in the light of his knowledge of Mona's experiences in Havana, Mr Yerkes interprets as a bid for food or other human favor, Mr Tomilin immediately accepted as an invitation to enter the cage He did so on the first day of the third month, without disturbance, and from that time onward was, as he puts it, accepted as a member of the family. He helped Mona to rock the babies when they cried, helped them to find a nipple; took one or other of them up or played with it as permitted This was all by way of cultivating intimacy, confidence, mutual habituation, as aids to scientific discovery Tom proved much more amenable to handling than did Helene

During the fourth month Mona became so friendly with the observer that she now and then attempted to kiss him[8] She seemed to enjoy the observer's presence, especially when he was willing to play with her. Ordinarily the play was a sort of wrestling—twisting, turning about, dragging, throwing—which was so rough and exhausting that the observer preferred short bouts Despite her 180 lbs. of weight or thereabouts and her immense strength of arm and body, Mona never injured her playfellow.

At times she permitted the observer to handle the twins freely; occasionally she objected. The two infants behaved very differently Tom seldom objected to being taken up, often he would take the observer's hand when it was offered Helene, after the first few days of acquaintance with this liberty on the part of the observer, almost invariably struggled, screamed, and clung tenaciously to her mother when Mr Tomilin tried to take her up. She was timid and distrustful; Tom was bold and confident Although very patient with Helene and the observer, Mona often was disturbed by the screaming and struggling of her infant and retrieved it promptly As a rule she cooperated with Mr. Tomilin, and not seldom when he tried to take Helene she would offer him the infant's hand or push her toward him

In the seventh month Mona's attitude toward Mr. Tomilin temporarily changed She became reserved, decidedly less friendly and cooperative. This change was attributed to jealousy, for a female (Fifi) with a newly born infant (Delta) had been placed in the adjoining cage. Mona could observe, and quite obviously resented, Mr Tomilin's attentions to Fifi and Delta when he entered their cage to feed or observe them. Toward Fifi herself, an old acquaintance, Mona exhibited at first marked friendliness and then relative indifference. After only a few days she came to accept Mr Tomilin's divided attentions as a matter of course or necessity, and her friendly relations, including wrestling bouts with him, were resumed.

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[8] This is a gesture which according to Mr Yerkes' information was encouraged in the Abreu colony. Whether it is natural to chimpanzee or the result of human suggestion has not been determined. See Yerkes (8, pp 187-188) and Yerkes and Yerkes (10, pp. 256, 296-297)

The twins were consistent in their behavior toward the observer, with the exception of a brief period, from the beginning to the end of the year. Tom's friendliness and aggressiveness increased. Toward the end of the year as soon as he saw Mr. Tomilin enter the cage he would run to and climb upon him. Helene's distrust persisted and if anything increased. She would not willingly permit removal from her mother, although occasionally when Mr Tomilin was playing with Tom she would steal toward him, slap at him, and rush away to hide behind her mother. By the end of the year Mona and Tom so fully trusted the observer that he could leave the cage with the latter in his arms.

When at one year of age the twins were separated from their mother, by strategy, and were examined minutely and measured, Tom was quiescent and silent throughout the process, whereas Helene struggled, now screaming loudly and now silent, and persistently tried to bite the hands that held her.

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LES JUMEAUX CHIMPANZÉ. RELATIONS DE COMPORTEMENT ET DÉVELOPPEMENT

(Résumé)

Ceci rapporte la naissance, le 26 juin, 1933, à la Anthropoid Experiment Station de Yale University, Orange Park, Florida, de jumeaux fraternels chimpanzé On en décrit le developpement et les relations maternelles pendant la première année de la vie. C'est le seul cas de naissance multiple d'un anthropoide qu'on connaise Les jumeaux, un mâle et une femelle, sont nés d'une naissance prématurée d'au moins quinze jours Ils étaient petits et faibles, mais de bonne santé.

La croissance a eté plus rapide pour la femelle dans les six premiers mois après la naissance Elle a été relativement beaucoup plus rapide pour le mâle pendant les six mois suivants, car lui, qui a mangé de bon appetit et rapidement, a pris de la nourriture supplémentaire facilement, tandis que sa soeur, qui a mangé peu et lentement, a très fréquemment refuse la nourriture A l'âge d'un an le mâle a pesé 5,88 kg, la femelle 4,32 kg

Tempéramment les enfants ont été très différents le mâle, actif, indépendant, aventureux, aggressif, relativement sans pour de personnes, docile, la femelle, disposée à s'attacher à sa mere, non aggressive, craintive, timide, relativement ayant peur même des observateurs, indocile, et apparemment obstinée.

La mere des jumeaux a pris soin de leur propreté, a exercé et a joué avec eux notamment moins que dans le cas des mères des petits uniques, selon notre observation A partir du commencement elle a montré une tendance à empêcher les petits de s'attacher à elle quand elle se reposait Pour accomplir ceci elle s'est service fréquemment de la punition Un tel comportement maternel n'a pas de précédent dans notre experience avec les mères chimpanzé

Dans ce cas la mère a été amicale et très coopérative avec les observateurs Vers la fin de la période du rapport elle permettait quelquefois à l'observateur de quitter sa cage, un petit dans les mains

La mère a enseigne aux petits à trouver la mamelle, à grimper, et à marcher D'ailleurs, dans les premiers mois, ils ont été bercés par le bras maternel pour apaiser leur irritation Vers la fin de l'année des efforts maternels pour sevrer les jumeaux ont commencé à se montrer. Cependant, l'allaitement et l'action de teter, la dernière devenant de moins en moins fréquente, ont continué jusqu'à la séparation finale des jumeaux de leur mère, âgés d'un peu plus d'un an.

TOMILIN ET YERKES

SCHIMPANSENZWILLINGE. VERHALTUNGSVERHALTNISSE UND ENTWICKLUNG

(Referat)

Dies berichtet uber die Geburt am 26 6 33 im Anthropoid Experiment Station der Yale Universitat, Orange Park, Florida, von Schimpansenzwillingen Die Entwicklung und mutterlichen Verhaltnisse werden fur das erste Jahr des Lebens beschrieben. Dies ist der einzige Fall einer vielfachen Geburt bei einem Menschenaffen Die Zwillinge, Mannchen und Weibchen, wurden wenigstens zwei Wochen zu fruh geboren Sie waren klein und schwach, aber gesund

Die Entwicklung war schnell bei dem Weibchen wahrend der ersten sechs Monate nach der Geburt Sie war verhaltnissmassig schneller bei dem Mannchen wahrend der folgenden sechs Monate, denn er, der ein grosser und schneller Fresser war, nahm nachtragliches Futter gern, wahrend seine Schwester, eine schlecte und langsame Fresserin, gewohnlich Futter ablehnte Als sie ein Jahr alt waren, wog das Mannchen 5,88 Kg und das Weibchen 4,32 Kg.

Das Temperament der Neugeborenen war sehr verschieden das Mannchen war aktiv, unabhangig, verwegen, streitlustig, verhaltnismassig furchtlos gegen Menschen, gelehrig, das Weibchen neigte, an die Mutter anzuklammern, war nicht streitlustig, war scheu, verhaltnismassig furchtsam, sogar gegen die Vl, ungelehrig und scheinbar sehr eigensinnig

Die Mutter der Zwillinge pflegte und spielte mit ihnen bedeutend weniger als bei Müttern, die nur ein Kind geboren haben, wie wir beobachtet haben Von Anfang an zeigte sie die Neigung, das Anklammern zu verhindern, wenn sie sich ausruhte. Um dies zu erreichen, straffte sie sie oft Solches mutterliche Verhalten hat kein Beispiel in unserer Erfahrung mit Schimpansenmuttern

In diesem Fall war die Mutter freundlich und hochst zusammenwirkend mit den Vln Gegen Ende der Berichtperiode gestattete sie dem Vl manchmal, dass er den Kafig mit einem Baby in seinen Handen verliesse

Lehrhilfe wurde den jungen Affen von ihrer Mutter bei der Lokalisierung der Brustwarze, beim Klettern und beim Gehen gegeben Weiter wurden sie wahrend der ersten Monate durch den mutterlichen Arm geschaukelt, um sie zu beruhigen Gegen Ende des Jahres begannen die mutterlichen Versuche, die Zwillinge zu entwohnen Milchbildung und Saugen aber, das letztere weniger, dauerten fort, bis die Endtrennung der Zwillinge von ihrer Mutter eintrat, als sie ein wenig mehr als ein Jahr alt waren

Tomilin und Yerkes

THE AUDITORY LOCALIZING BEHAVIOR OF THE WHITE RAT IN RELATION TO CEREBRAL FUNCTION*

From the Psychological Laboratories of Brown University

L. A PENNINGTON

Although numerous experimental investigations of mammalian audition have been carried out, only a few have dealt directly with the behavior of the animal as a function of the spatial "source" of the sound. In studies of audition in other forms, localizing behavior has seldom been more than incidentally referred to Meyer (6) has reported a genetic study of auditory localization in the human individual and in representatives from many other species of vertebrates. His criterion of localizing behavior was based upon the animal's overt response to the sounding whistle These motor responses were classified for the various age levels of his human subjects and of his various mammalian subjects. Szymanski (10) investigated localizing behavior in cats and dogs to a bell stimulus, interpreting his negative results, after thirty trials, in terms of the inadequacy of his apparatus. Barber (1) suggested that the solution of Szymanski's problem was prevented by the position habits of the animals and by the small number of trials given. Johnson (3), working with dogs, reported that, in controlled experiments, the four animals used learned in 165 trials to approach the food-box over which the sounding buzzer was suspended.

The white rat has been used in a number of studies of locomotor responses to sound stimulation Barber (1) specifically attacked the problem of the white rat's accuracy in auditory localization Seven animals in her study learned in 40 to 136 trials to approach the vicinity of a stimulus tap. Retention of this food-getting response to the tapping of a chisel on the stimulus board surrounding but separated from the reaction chamber was present after a forty-day interval Barber also reported the lack of locomotor localizing

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*Accepted for publication by Leonard Carmichael of the Editorial Board and received in the Editorial Office, September 13, 1934

responses to tones Thuma (11), who used a T-shaped soundproof discrimination chamber, trained the white rat to discriminate two tones after a large number of training trials had been given This investigator suggested that the accuracy of the animals in responding differentially, one tone requiring the animal to run left, the other requiring the animal to turn right, was dependent upon *the localizing capacity of the animal studied.* Muenzinger and Gentry (8) used a Y discrimination arrangement in which the rat had to respond differentially to a directed tone coming from the region of one arm or the other of the Y. Two groups of animals were used, those learning to approach the sound-filled alley and those trained to choose the silent alley Both groups learned the response in about 150 trials. These investigators reported the behavior of the white rat before locomotor response to be that of a "listening" animal. Gentry (8) has considered this behavior to have a definite relation to the success or failure of the animal in a problem situation It appears possible, however, that the rats in this study were using a cue in some way related to that which would be used in auditory localization

The capacity of the white rat to localize noise stimuli has been noted by the writer in a maze study (9). The aim of this investigation was to note the effect of extra-maze buzzer stimulation upon the rat's learning of a complex elevated maze pattern Animals learning without this sound stimulation required more than two and a half times the amount of time and trials necessary for other animals learning with constant buzzer stimulation from the left of the maze Quantitative evidence of localization in this study came from an analysis of errors made by the group learning with sound This analysis indicated that the rat had been able to localize noise at the left and that a change in position of the sound source to the right demanded a reorientation. Wiley (14), however, has reported negative results in auditory localizing discrimination experiments Several procedures were used and a large number of training trials given in each instance The apparatus was then modified and the rat was now trained, this time successfully, in less than 200 trials to make a simple auditory-determined response on a T-maze arrangement

In view of these studies and in light of the genetic study by Wada (13) of the development of the rat's internal ear structure, which indicates a morphological similarity to the comparable human sense organ, the present investigation was undertaken.

STATEMENT OF THE PROBLEM

The immediate aim of the present study was to develop a technique whereby a quantitative measurement of the rat's capacity to localize noise could be obtained. Several investigations have reported evidence for and against localizing behavior in the white rat In general, the chief difficulty appeared to rest with the apparatus and with the procedure utilized The writer's study (9) of the rat on the complex maze, in which extraneous auditory stimulation was supplied from the left, revealed both in quantitative results and in observation of the animal's behavior that some sort of localizing ability might be a determining factor in the rat's maze responses. It seemed therefore that localizing ability could be made the sole differential criterion in an animal's success or failure in a behavioral situation.

A second objective of the study was to observe the effect of specific cortical destruction upon the auditory localizing behavior of the white rat This second objective has been dealt with only in a preliminary way in this paper and is at present being studied further by the author.

EXPERIMENTAL PROCEDURES

A series of tentative experimental procedures was tried in order to determine whether or not it was possible to establish in the white rat a habit which was dependent upon the differential stimulus cues of the sort that are basic to the auditory localizing response. The first two procedures yielded negative results The third method, slightly modified to become the fourth, gave positive results.

1. An elevated T maze was arranged in the soundproof room at the University of Michigan Psychological Laboratory The aim of this experiment was to construct an experimental situation in which the rat would learn to turn toward the sounding buzzer for food. Two electric buzzers were used with a double-throw switch which made it convenient to present the series LRRLLRLRRLRLLR. Ten male white rats were given 400 trials with only chance results. This technique was discontinued

2. A string-pulling procedure, described earlier by numerous in-

vestigators and most recently and in greatest detail by Klüver (4), was arranged in the Psychological Laboratory at Brown University. Four male white rats were trained with an alternation series to pull in a sounding buzzer with an attached food cup. The silent buzzer-food cup and string attachment constituted the negative stimulus. The four animals learned in 200 trials to make this positive response A control experiment was carried through. The food cups were detached from the buzzers, the animals now were required to pull in the cup, placed in front of the sounding buzzer. Three hundred trials were given each of the four animals with only chance results. The earlier successes with the buzzer-cup arrangement seemed to indicate that the response was to vibrotactile and not to auditory cues Recently, however, Trueblood and Goldfarb (12) have continued this method and have reported positive results with three animals Each white rat required approximately 850 training trials before control tests were given, after which these investigators conclude that the response is one of differential localization in audition

3. Following the attempt with the string-pulling procedure an elevated Y maze was substituted This maze stood 25 inches above the floor and rested upon celotex. The maze, likewise, was enclosed in a celotex chamber, 11 by 7 by 4 feet, which was lined with unbleached muslin. The arms of the Y (see Figure 1) had return paths, *L*, running toward the front of the enclosure Each Y-arm extension therefore connected directly with the food-box itself partitioned into two divisions, an entrance space which led to a food compartment through a small aperture. The pathway of the maze standards was ¼ inch in width, which, it was thought, in the light of Miles's study (7) of an elevated and enclosed identical maze pattern of different widths of pathway, would place a premium upon the correct choices as against chance responses. The interior of the reaction chamber was lighted by a 25-watt electric bulb located directly above the Y fork. The stimulus was a single electric "medium frequency" buzzer mounted by heavy rubber bands to the corners of a three-sided celotex-lined box, which, in turn, was suspended through apertures in the top of the reaction chamber in one or the other of two hollow columns, *C* in Figure 1 Each of these columns was located five inches distant from one end of the Y arm. The front of each column was so covered with unbleached

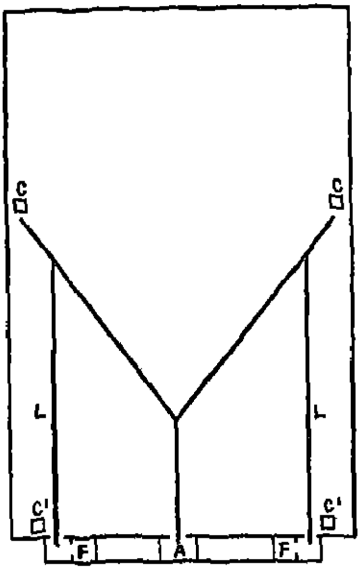

FIGURE 1

DIAGRAM OF THE EXPERIMENTAL APPARATUS

C indicates the original position of the buzzer columns, and *C'* represents the position of the columns after the original procedure had been modified. *A* is the entrance compartment to the reaction chamber. *F* is the food compartment Individual home cages for the experimental animals were used Scale ½ inch to one foot

muslin that the buzzer mount was invisible Each column rested upon the cement floor of the laboratory maze room Neither column came in contact with the celotex muslin-lined walls of the enclosure. The buzzer columns themselves were 4⅛ feet in height and were 7¼ inches by 6 inches in width The buzzer box was 5 inches square by 8 inches in height, outside dimensions. The buzzer, as arranged, was thus easily transferred by the experimenter to the second column as required by the alternation series The buzzer assembled in its support was lowered to a distance of 25 inches above the floor in the hollow column and was so suspended that the buzzer was approximately level with the maze pathway. This stimulus source was chosen so that the same stimulating instrument might be used for each position in the alternation series

EXPERIMENTAL PROCEDURE I

Ten female white rats were used in the type of Y-maze situation described above These animals were all three months of age at the beginning of the experiment Each animal was given a seven-day training period in a practice Y set up outside the enclosure, during which interval all animals learned to traverse the narrow pathway with agility and speed The individual animal was allowed daily six grams of McCullom's diet fed as a dry meal with additional bits of dog biscuit soaked in cod liver oil Fresh lettuce for the group was placed in the food compartment of the reaction chamber during the experimental periods The food which remained after these intervals was placed in the living cage containing the ten animals In this manner the amount of food consumed by each white rat was approximately proportioned

After this preliminary training on the practice maze the rats were transferred to the reaction chamber arrangement and the actual experimental procedure was begun. For this experiment, the food cup and the buzzer source were for seven of the ten animals left, then right, right, and so on through the arbitrarily selected alternation series LRRLRRLL. For the remaining three animals the food cup was located in the opposite food compartment of the reaction chamber, and therefore required the animal to make a negative locomotor response to the continuously sounding buzzer source Each animal was placed by the experimenter at the foot of the Y, *A* in Figure 1, and allowed to run to one or the other of the food compartments After each alternation trial the animal was taken from the food-box regardless of error for this trial and placed in an individual compartment outside the reaction chamber. The same order of animals for each alternation trial was maintained throughout the series of eight runs which composed the daily series. This procedure, with the buzzer columns located at the end of the Y arms, was discontinued after chance results had been obtained with 256 trials. The experimental situation was then modified

The modifications of the above apparatus included the change in position of the buzzer columns *C* to *C′* and in the addition of a block to the entrance of the incorrect food-box. The presence of this block thus required the seven animals when in error to retrace and enter the proper food-box next to the sounding buzzer. For the three animals required to make the negative response to the noise source, the food-box adjoining the sounding buzzer was blocked With the buzzer arrangement placed only four inches from the entry of the Y-arm extension to the food-box the continuously sounding buzzer stimulations would come either from the right or left of the animal upon its entrance to the maze chamber at *A* Further, each animal was allowed to eat at the food-box for a period of thirty seconds, which, it was surmised, might help in the fixation of the successful response In addition, as a possible olfactory control, food-cups were kept in each food-box throughout the daily alternation trial series In light of these modifications the following procedure was used.

Seven of the ten female white rats of Wistar stock used in the foregoing procedure were selected for training under the modified conditions. One group of four animals was trained to make a positive locomotor response to the source of the sound, while with the other group of three animals training was continued toward the establishment of a negative response to the same stimulating conditions. Records were taken both in terms of right and wrong choices and in terms of the time each animal required to run from *A* to *F, F'*. All other experimental conditions remained unchanged with reference to the original procedure. Results in terms of an increasing accuracy for each daily alternation series indicated that the seven animals in the two experimental groups exceeded an arbitrarily chosen criterion of 75-per-cent accuracy for a period of ten days during which time eight trials were given daily It so happened that in the number of trials given all the seven animals exceeded the "easier criterion" of Muenzinger and Gentry (8) of 80 per cent, while three of the seven attained better than 90-per-cent accuracy, which satisfied the criterion used by Hunter in his investigations with tone discrimination with the white rat. It was therefore decided that each animal should be held to its individual level of performance achieved in the original learning period in retention tests. In each case this individual criterion has exceeded 80-per-cent accuracy in 80 consecutive trials

After training had been completed, a number of control experiments were performed to ascertain whether the localizing behavior was a function of the differential auditory stimulation or of some uncontrolled sensory cue The control experiments were as follows.

1. To eliminate the possibility of any visual cues the animals were tested in the dark. Records indicated that each animal maintained a level of performance which satisfied the criterion It was noted that some animals made better records than previously. Analysis of the time in seconds required to run the maze in the dark as compared with the same response in the presence of light indicated that greater time was required in the dark.

2 To eliminate the possibility of vibratory cues from the experimental situation the buzzer mount was suspended from the ceiling of the maze room. Contact with the hollow columns was made impossible in this way. This experimental test gave no evidence of a disturbance in performance of any of the seven animals. As a further check it was thought advisable to remove for a series the block to the incorrect food compartment in order to eliminate possible differential echoes which might be thought to arise therefrom during the daily experimental periods. The animals still maintained their original level of localizing behavior

3. To eliminate the possibility that the animals had learned the experimental alternation series this series was changed three times. These changes were as follows· LRRLRRL; LLRRLRRL; RRLRLLRR. The results from these tests indicated a slightly higher degree of accuracy of performance than most of the seven animals showed with the original LRRLRRLL training series.

4. To eliminate further the possibility of an olfactory cue the maze pathway was washed with a clean damp cloth after each trial for an alternation series A disturbance in time was noted, but each animal maintained the criterion first chosen, and a few exceeded this by some points.

5. To eliminate the possible cue from handling the animals the experimenter modified the usual procedure. During the actual daily experimental periods the experimenter placed the animal in the small compartment *A* which led into the reaction chamber when a panel was lifted. The operator previously had opened this door while the animal was in the compartment. In order to eliminate a possible cue from this source, the door was opened by a string attached to the knob of the panel and pulled from the rear of the enclosure by the experimenter. No disturbance was noted in time or in responses.

6. To eliminate further uncontrolled cues and to determine whether or not the performances of the seven animals were dependent

upon the sound source, buzzer stimulation was omitted altogether. During this test the block was removed from the food compartment entrance. Food was thus available in each box. The seven animals all gave chance records showing almost exactly a 50-50 relationship.

7. To determine further the dependence of the animal upon sound stimulation the intensity of the buzzer stimulus was increased. The results indicated that the rat was affected by the change in the degree of intensity. The three animals trained to run away from the sound source now scored perfect trials. The four animals trained to run toward the sound source showed what might be characterised as emotional disturbance, lengthened time, and a tendency to avoid the pathway which led them to the food-box adjacent to the noise With the decrease in the sound intensity to its former amplitude, all animals maintained their original level of performance

From this series of control experiments it was asserted with assurance that no animal was reacting to secondary cues in the experimental series Rather, it appeared that each rat was responding to the noise stimulus and that consequently the animal's success in choosing the correct food compartment appeared to be dependent upon the animal's capacity to localize the position of the source of the sound. This seemed directly apparent, moreover, from observation of the animals as they approached the junction of the forks. The "choosing behavior" of Muenzinger and Gentry was clearly in evidence in the present experiment. Typically an animal would move first to one arm and then to the other at the point of junction. Sometimes an animal might sit up on its hind feet and appear to "listen," turning its head first one way and then another. It seemed probable to the experimenter that one might well attempt a correlation of localizing behavior on the basis of these overt responses as contrasted with those situations in which the animal ran very rapidly from the restraining compartment upon the maze and appeared to pay little "attention" to the auditory stimulus. If such a "subjective criterion" had been accepted, which it was not, the performance might well have approached 100 per cent.

Under the experimental conditions described above, the following results may be offered with reference to the group of seven female white rats, four of which were trained to make a positive localizing response to a noise stimulus, and three of which made a negative reaction to the same stimulus source.

1. The white rat can be brought to make both positive and negative responses which may be shown to be dependent upon the position of the generating mechanism producing the energy of the auditory stimuli used in this study.

2 Each animal was able to exceed the "easier criterion" adopted by Muenzinger and Gentry, and three of the seven were able to attain the criterion which Hunter chose in his studies of the rat's sensitivity to tonal stimulation.

3. Under the modified experimental conditions the seven selected female white rats were able to reach this level of performance with 328 trials With the original experimental arrangements, these animals had been given 256 trials. A total of 584 training trials, therefore, was given each animal

4. The series of control experiments, far from indicating any detrimental effect upon the performance of the seven animals studied, showed in certain instances actually a higher level of performance than had been attained up to that time in the regular training series This increase, however, was not greater than might have been expected as a result of the additional trials given in the control series.

5 An analysis of the time records for each animal in the last 80 consecutive trials indicated that the animal running toward the sound travelled faster on the average in each trial than did the animal running away from sound This statement is in agreement with the writer's note on the superior speed with which the white rat travelled toward buzzer stimulation on an elevated maze as contrasted with the slower rate of movement away from the sound source. The average time for each correct response for the group running from sound was seventeen seconds This rate may be contrasted with the ten-second rate per trial for the group running toward the sounding buzzer and the adjacent food-box. A further analysis of the final 80 trials in terms of time records showed no significant difference between right and wrong choices with animals running either toward or away from the buzzer source

EXPERIMENTAL PROCEDURE II

An additional group of ten male white rats was given a training period each day for seven days upon a narrow-pathway elevated maze. They were then transferred to the modified experimental arrangements already described This group of animals of Wistar stock, all exactly three months of age at the beginning of the experiment, was required to make only positive locomotor responses to the sounding buzzer. Each animal was given two alternation series of eight trials each daily, one in the early morning and the other in the late afternoon. The actual experimental procedure was a repetition of that used with the group of seven female animals under the modified conditions of the first experiment. Following the training period those ten animals were given a series of tests identical with those given the seven animals of Experiment I, except for the omission of the test trials involving the change in the intensity of the buzzer.

Results of this second experiment are presented below

1. Nine of the ten male white rats of this group were trained in 648 trials to make positive locomotor responses to an auditory stimulus source. These animals achieved a mean accuracy of 85 per cent for the consecutive series of final 80 trials, which series constituted the experimental criterion. One animal, number 13, showed persistent "position habits" throughout the training period, and experimentation with this animal was discontinued.

2 During the experimental control tests the nine animals reached a higher mean score in accuracy than the group had obtained with the final 80 trials of the original training periods This statement is substantiated by the mean score in accuracy for the control series of 91 per cent as contrasted with the mean score in accuracy of 85 per cent in the final 80 trials of the daily training alternation series. It is suggested that this higher score in percentage of accuracy for the group in the control series may be due to the continuation of the training in an experimental situation which the animal has not yet completely mastered. Further, this higher percentage of accuracy in the second experimental control series might be explained to a degree by the omission of the intensity changes which have been reported earlier to bring about notable disturbances in all animals trained to make a positive response under the conditions of Experiment I.

3 A further vibrotactile control was attempted The vibrissae of one animal, number 19, were cut during the control series. This animal passed all the tests.

From these results and from the observations of the animals' behavior at the Y fork, it was concluded that the nine white rats in

Experiment II were making orienting locomotor responses dependent upon the position of the auditory energy source.

Discussion of Experimental Data

The experimental data thus far presented have indicated that the white rat can be brought to make directional locomotor responses dependent upon the position of an auditory stimulus. It would appear that under the experimental conditions described earlier a demand is placed upon the animal's capacity not only to localize the sound stimulus in its environment, but also to relate the position of the noise with the position of the reward. This demand upon the sensory capacities of the white rat, when the animal is placed in such a totally novel and artificial environment as the present study has involved, indicates in the light of the positive results recorded above that the albino rat is capable of responding differentially to a very slight auditory cue Similarly, such slight cues have been shown by numerous investigators to play an important rôle in auditory localization of the human subject. An analysis of the animal's ability to learn this specific discriminative behavior pattern is therefore of value. It also forms an excellent basis for the comparison of the experimental behavioral results obtained in regard to this characteristic and discriminative response both before and after cerebral lesion.

In both experimental series the calculations were made in terms of the absolute number of errors made and in terms of the percentage of accuracy. For the study of the absolute number of errors the records of the training trials for each group of animals, seven female white rats and ten male animals, were divided statistically into a number of groups of trials Each such statistical group was arbitrarily set at 80 trials each. In order to make comparable these arbitrary divisions of 80 trials each, they were counted off from the final training period during which the animal gave positive evidence of localizing behavior. For each such trial sequence the mean number of errors for each alternation series of eight trials each and the standard deviation of the error distribution were computed. These computations were then recorded in order of the trial sequences, and therefore in the forward direction. Table 1 indicates these mean values for the two groups of animals for each sequence of 80 trials. In this table the error score of the median animal in each group has been included for sake of comparison.

TABLE 1

MEAN SCORES IN ERRORS FOR EACH STATISTICAL GROUPING*

	1		2		3		4	
	M	σ	M	σ	M	σ	M	σ
Female mean	4 03	85	4 03	1 07	4 07	88	3 7	.77
Female median	4 0	0	4.0	1 0	4 0	1 0	4.1	.7
Male mean	4 3	.91	4 0	.92	3 7	94	3 02	1 1
Male median	4 1	7	4.0	79	3.7	9	3 1	.54

	5		6		7		8	
	M	σ	M	σ	M	σ	M	σ
Female mean	2.97	1 06	2.1	93	1 02	.63		
Female median	2.9	82	2 0	1 2	1.0	78		
Male mean	3.0	.66	3 0	1 1	2.1	95	95	.42
Male median	3 3	1 0	3.1	1.2	2.2	85	1 0	44

*This table contains a summary of the mean number of errors and standard deviation in errors for each training sequence of 80 trials These values are presented for both groups of animals The median score in errors for each sequence unit accompanies each sequence value for use in comparison with the mean in errors.

With the seven female animals trained under the conditions of the first experiment the mean number of errors indicated only chance records up to the fifth sequence of 80 trials each. Improvement, as shown by the decreasing mean of the errors and a steadily decreasing standard deviation, does not appear before about 400 training trials have been given. On the other hand, these seven animals appear to achieve their greatest accuracy in the seventh sequence of 80 trials at which point the mean error and standard deviation scores are smallest. It was immediately after this training sequence that the control experiments described above were carried through

Data obtained under the conditions of the two experimental procedures were further analyzed by calculating the mean percentage accuracy of localizing responses of the two groups of animals for arbitrarily selected statistical groupings of 40 consecutive trials each. These results agree in the main with those derived from a study of the mean score in errors for each sequence of 80 training trials Further, these mean values in accuracy show for the seven animals in this experimental group that there exists no positive evidence of improvement in oriented locomotor responses before 400 training trials have been given The values also show the presence of a gradual rise to a high degree of accuracy after about 480 trials. No significant difference was noted between those animals trained to make the positive response as compared with those trained to respond negatively.

The analysis of experimental data was repeated for the nine animals trained under the conditions of the second procedure The mean scores in errors, summarized in Table 1, for each sequence of 80 training trials showed the initial chance responses of the nine cases Table 1 also indicates a period of training during which the mean scores in errors disclosed less than chance responses. A study of observational data brought out the fact that it was during this period that the so-called "position habits" were formed Indeed, it was during this period that the experimenter withheld reward regardless of the choice at the Y fork in the effort to disrupt such performances After this had been accomplished, actual improvement with the nine animals of this group was not apparent from the experimental records or from non-quantified observations until after 480 trials had been given. There followed then a gradual rise in accuracy as shown by the mean score in errors of 95 for 80 trials in the eighth statistical sequence.

The statistical values in terms of mean errors in 80 trials for the nine trained animals of the second experimental group were borne out by the analysis of the behavioral data in terms of percentage accuracy for each statistical grouping of five alternation series of eight trials each. With reference to the first statistical grouping of this series there is brought out an observation made upon several animals trained to make a positive locomotor response to buzzer position. It had been noted during the early stages of the training period that these animals tended to run away from the sound when first placed in the experimental situation This would seem to indicate that a negative response would be more readily formed than a positive reaction This observation was not supported, however, by the records obtained from the three female white rats trained to make a negative response to the noise source The mean values in percentages of accuracy for the positive and the negative cases showed slight deviation in the cases of the first experimental group. In view of these conflicting results from the two groups of animals, further experimentation obviously would be necessary before any conclusion could be offered as to the validity of the observation described above. Following training-trial 520, however, there appeared a continuous rise to a high level of performance, after which the nine animals were able to pass all the control tests with a higher mean score in percentage of accuracy than the group had shown during the final 80 training trials. The final percentage of training accuracy reenforced by the increase in mean scores in accuracy throughout the control experiments has been taken as evidence for the presence of auditory localizing behavior of the white rat.

If an analysis is made of the training periods given under the conditions of the two foregoing experiments, the following steps in the learning process in this situation may be noted.

1. An extended period, exceeding 400 trials, during which the two groups of animals showed only chance responses
2. A shorter period, approaching 200 trials and overlapping with the 400 trials mentioned above, during which the nine male animals in particular gave evidence of "position habits" As a speculation it may be said that the absence of persistent responses in the first experiment possibly may have been due to the modification of the experimental procedure at the time such habits seemed to appear in the animal's reactions when trained under the conditions of the second procedure.
3. A final period, approximately of 100 trials, during which the animal gradually achieved a higher degree of accuracy and after which sixteen out of seventeen animals were able to pass a series of control experiments with increasing accuracy. Improvement appeared to continue with the test series after actual training with the original learning alternation series had been discontinued. This final period of improvement may suggest an explanation for the negative results obtained by Wiley (14) with a Y maze and those obtained by the writer with a T maze. It will be remembered that with 500 trials Wiley gained little or no evidence for more than chance results The present writer found only chance records with 400 training trials with the T arrangement. It is suggested, in view of the experimental data presented in this study, that had Wiley continued the training period for an additional 200 trials evidence for auditory localizing behavior might well have appeared.

Reference has been made to the observable localizing behavior of the animals during the final stages of the training period. This form of behavior, called by Muenzinger and Gentry "choosing behavior," was not observed prior to the 400th trial It was noticed particularly in the last 100 trials. It was during this period that the animals began to show a higher degree of accuracy, both in the training and in the test series. Each animal was always carefully watched at the Y fork before the choice was made. If what has been defined as "overt localizing behavior" was apparent, a record was made of this judgment. These records, then, were studied and compared with the accuracy of the ensuing runs. It was found with this subjective criterion that rarely, if ever, was an error made. With the increasing accuracy of the final 80 trials there was noted in the records an increasing number of these judgments based upon the behavior of the animal at the Y fork. From the relationship which appears to exist between such a criterion and the animal's accuracy of localization it appeared likely that in those runs during which such behavior was absent and when the animal ran out very rapidly from the restraining compartment, the factor of "lapses of attention" might from one point of view be held responsible for many errors. It is to be noted that investigators with similar problems have made comparable observations. This overt localizing behavior and possible "lapses of attention" have been described by Muenzinger and Gentry and mentioned by Thuma.

CONCLUSIONS BASED UPON BEHAVIORAL STUDY

1. In Experiment I three animals learned with 584 trials to make a negative directional locomotor response to a specific noise stimulus whose source varied in position from trial to trial. Four animals learned with 584 trials to make a positive directional locomotor response under the same experimental conditions. These animals achieved an accuracy which exceeded 80-per-cent-correct responses during a period of ten days in each of which every animal was given eight trials.

2 In Experiment II nine of ten animals were trained successfully with 648 trials to make a positive locomotor response which was shown to be a function of the position of the buzzer which generated the auditory stimulus These nine white rats achieved an accuracy exceeding 80-per-cent-correct responses during a consecutive series of the last 80 training trials

3 Analysis of the training period in terms of errors and in terms of percentage of accuracy for statistically selected groupings of train-

ing trials indicated that the experimental animal made only "chance" records through 400 trials; that "position habits" appeared during the later portion of these 400 trials and persisted for some time until disrupted by a slight modification in the experimental procedure; that actual "overt localizing behavior" appeared somewhat gradually within the final hundred trials, after which the animal passed the control tests with increasing accuracy.

4 The results from the control experiments and from the observations upon the animals' choosing behavior permit the conclusion that the white rat under the experimental conditions described above is capable of localizing a specific noise stimulus located in the animal's environment

Postoperative Retention

The sixteen white rats trained to make differential responses to noises as described above were subjected to the following procedure. All these animals, after they had reached and maintained a high level of accuracy during the control experiments, were given a ten-day rest period in agreement with the general method adopted by Lashley (5) in his detailed studies of the neural correlates of the white rat's behavior Each animal was then given a preoperative retention test for the localizing response to the buzzer stimulus which still varied in spatial position dependent upon the alternation series. Each animal was retrained at this time until the original level of accuracy of localization was reacquired. A cortical operation was performed immediately thereafter during which procedure aseptic precautions were taken. The lesions were made for the most part in the posterolateral regions of the cerebral hemispheres Ten days after the operation the animals were again returned to the situation Each animal was trained until it reached its own original criterion of localizing behavior, or until, after very prolonged experimentation, it seemed unable to reach this criterion If this criterion was reached, the operated animal was given a control test consisting of a different series of alternations to rule out the possibility that a position habit or a response to a learned alternation was determining the behavior.

Six of the sixteen trained animals were operated upon Following the retraining period the animals were killed, their brains removed, fixed, sectioned, stained, and mounted The percentage of cerebral lesion was then determined by means of a proportional divider and by planimeter measurements. By this method the location and magnitude of the lesion was determined and quantified The ten animals not subjected to cerebral lesion were given the same operative tests, and so were held as normal control cases in order to check the retention of the auditory localizing habit after a delay of ten days followed by a second ten-day rest interval.

The following statements may be made in summary of the preoperative retention tests and of the control cases used in the postoperative test period

1. All experimental animals under the two experimental procedures used in this study reacquired their original levels of localizing behavior in less than 70 trials after an initial ten-day rest period.
2. All control animals, ten in number, reacquired their original levels of accuracy in localizing a noise source in less than 105 trials after a second ten-day rest period.
3. It was concluded that normal animals retain the auditory localizing response during two ten-day periods of rest with only slight imperfection This statement is based upon the number of trials required by the animals to regain their original levels of localizing behavior.

The following results, which depend for their verification upon a more detailed analysis, were obtained from the six cases subjected to cerebral lesion following training in the discrimination between positions of a noise stimulus in space Four of the six cases were given bilateral cerebral lesions in the posterolateral area of the hemispheres. From a study of postoperative trials and errors these four lesions showed an effect upon auditory localizing behavior which was roughly proportional to the size of the cerebral insult. The size of the lesions within *area p* ranged from 16.7 to 24 per cent The number of retraining trials necessary for the animals to regain their former level of performance ranged from 256 (75 errors) to 1224 (509 errors) In the case of the animal which was given 1224 retraining trials, however, there were obtained only chance results. This animal failed completely to reacquire its former level in training of 97 5-per-cent accuracy in localization It was believed that the inability of this animal to reacquire the localizing habit was due to the destruction of subcortical structures which might well have involved the auditory radiations.

Two additional cases with lesions in the frontal brain areas, ranging from 20 to 23 3 per cent in size, produced no disturbances in the auditory localizing responses of the animals. Inasmuch as *area j* was involved in these two cases it might be argued that *area p* of the posterolateral brain region alone was functional in auditory localization.

This brief analysis has suggested that *area p* is functional in the type of behavior under consideration, although more cases are necessary before the validity of the statements made above can be assured.

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LE COMPORTEMENT AUDITIF LOCALISANT DU RAT BLANC À L'ÉGARD DE LA FONCTION CÉRÉBRALE

(Résumé)

Les résultats de cette expérience montrent que l'on peut entraîner le rat blanc à faire des réponses différentielles à des stimuli auditifs de bruit lesquels ne sont différents qu'à l'égard de leur position spatiale dans les environs de l'animal. On a fait venir telles réponses avec succès chez 16 animaux après des périodes d'entraînement variant de 584 à 648 épreuves. L'appareil employé s'est composé d'un labyrinthe en forme de Y, élevé, spécialement construit, à sentiers étroits, lequel on a protégé presque complètement contre les stimuli occasionnels. Des expériences de contrôle pour gouverner la détermination possible du comportement différential par des suggestions autre que le locus spatial du stimulus auditif ont donné des résultats negatifs. On a produit expérimentalement des lésions cérébrales chez 6 des 16 animaux entraînés. L'étude du comportement postopératif de ces 6 animaux operés, en comparaison avec le groupe de contrôle des animaux entraînés mais non opérés, a montré des degres variants d'interférence avec l'habileté antérieurement établie à localiser spatialement le son. L'étude histologique a montré que cette interférence a été assez proportionnelle à la grandeur de la lesion dans *l'aire p* de l'écorce. Il faut considérer ces résultats sur la fonction cérébrale à l'égard de l'habileté auditive localisante du rat comme explorateurs et tentatifs.

PENNINGTON

DAS LOKALISIERENDE GEHÖRVERHALTEN DER WEISSEN RATTE IM VERHALTNIS ZUR GEHIRNFUNKTION

(Referat)

Die Resultate dieses Experiments beweisen, dass die weisse Ratte trainiert werden kann, unterscheidende Antworten auf Gehörreize zu machen, die sich nur in ihrer Raumlokalisierung in der Umgebung des Tieres unterscheiden. Antworten dieser Art wurden in 16 Tieren erfolgreich nach Übungsperioden von 584 bis 648 Proben hergestellt. Der Apparat bestand aus einem speziell gebauten Y-Labyrinth, das fast ganz vor zufalligen Reizen geschutzt wurde. Nachprufungsexperimente zur Kontrolle der moglichen Bestimmung des unterscheidenden Verhaltens durch Leitfaden ausserhalb der Raumstelle des Gehorreizes ergaben negative Resultate. Gehirnverletzungen wurden in 6 der 16 trainierten Tiere experimentell erzeugt. Nachoperative Verhaltungsuntersuchungen dieser 6 operatierten Tiere zeigten im Vergleich zur Kontrollgruppe verschiedene Grade der Interferenz mit der vorher festgelegten Fahigkeit, den Laut raumlich zu lokalisieren. Histologische Untersuchungen zeigten, dass diese Interferenz ungefahr proportional zu der Grosse der Verletzung innerhalb der *Flache p* der Rinde war. Diese Ergebnisse von der Gehirnfunktion im Verhaltnis zu der lokalisierenden Gehortatigkeit der Ratte mussen als forschend und probend angesehen werden.

PENNINGTON

ARE THERE TWO SPECIES OF TWINS?*

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STEVENSON SMITH

We are reasonably sure that among human twins there are those of monozygotic origin and those of dizygotic origin We are considerably less sure of the diagnosis of any particular pair of twins. The criteria for distinguishing monozygotic from dizygotic are of two sorts The first group of criteria concerns the character of the placenta and related structures which may be observed at birth. The second class of criteria have to do with the measurement of physical traits and the degree of similarity of these traits as observed in the twin pairs. No absolute criterion for distinguishing monozygotics from dizygotics has yet been proposed. None is free from doubt. The examination of the afterbirth is generally conceded to be a better means of diagnosis than is the examination of the physical resemblance of the individuals The former, however, is not always feasible and the measurement of physical traits has the advantage of being possible at any age.

In the measurement of physical traits of twins evidence can be found for the existence of two species, and a reliable criterion can be devised for the diagnosis of the two species This paper reports an experimental effort to prove the presence or absence of two species of twins, and includes a proposed method for the diagnosis of individual pairs

THE PRESENT STUDY

Our assumptions are that if monozygotic twins exist they occur only in pairs of like sex, and, further, that they are as a group more similar in any trait than are dizygotics. It would follow, then, that, if monozygotic twins exist, pair *differences* would be less in unselected twins of like sex than in the unselected twins of unlike sex Through a study of the distribution of these differences we can arrive at a criterion of monozygotic twins

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*Accepted for publication by Carl Murchison of the Editorial Board and received in the Editorial Office, September 18, 1934.

Sixty-nine pairs of twins of like sex and seventy pairs of unlike sex were measured for height and weight. Coats, sweaters, and shoes were removed Forty-three of the pairs of unlike sex were Oakland, California, children, measured under the direction of Dr. Harold E Jones, who generously contributed his results to this study. The rest were Washington children from Seattle and Spokane All measures were converted into standard scores according to age and sex in order to make possible the calculation of differences in boy-girl pairs and to keep age constant. Highly reliable standard deviations for height and weight do not exist. Those used in this study were derived from Baldwin's reported M.D's and then smoothed. Height and weight means were taken from the Baldwin-Wood tables

Any trait, such as height or weight, is distributed approximately as a probability surface from which we may compute the mean and standard deviation of the trait. The *differences* in magnitude between random individuals of the population also constitute a frequency distribution The mean of this distribution is zero; its variance is twice that of the trait in the population (The variance is the square of the standard deviation) If more than chance similarity exists between the pairs, i.e, if the measures are correlated as in the case of familial resemblance, the S D of the score differences will be less than chance expectation. If complete similarity exists between the pairs the S.D. of the score difference will be zero.

TABLE 1

THE DISTRIBUTION OF THIS SAMPLE

	Like sex		Unlike sex		Diff.
	Mean	S D	Mean	S D	$\frac{\text{Diff.}}{\text{S D}_{diff}}$
Standard score height	+ .15	1 34	— 28	1 27	1 94
Standard score weight	— .34	1 68	— 40	1 38	23
Standard score Ht-Wt	+ 50	1 22	+ 14	1 06	1 85
Age in years	10 46	2.55	12 86	2 89	

The twins of like sex were found to be taller and considerably lighter than the general population from whom the Baldwin-Wood norms were derived The twins of unlike sex are both shorter and lighter than average and under weight for their height. Both these groups showed a greater than normal variability in height and weight The mean of height minus weight shows the average excess of the children's height beyond expectation from known weight. This excess of height is much greater for the like-sex group and might suggest that monozygotic twins are of slighter build. The S.D. of height minus weight is a measure of the degree in which the individuals are like themselves, the degree in which their divergence from the mean in height corresponds to their divergence from the mean in weight. If there were no correspondence in the height and the weight deviations in the individual, the expected S.D. would be 1.73 for the like-sex group and 1 50 for the unlike-sex group. If there were perfect correspondence in the two traits the S D.'s would be zero. The ratio of observed correspondence to chance correspondence is the same (71) for both groups. So we may conclude that there is the same degree of pattern variability among the individuals in the twins of like sex and in the twins of unlike sex.

TABLE 2
THE CORRESPONDENCE OF TWIN PAIRS

Double entry *r*	Like sex pairs	Unlike sex pairs
Height	72± 03	.44± 05
Weight	.74± 03	.37±.05
Ht -Wt.	.76± 02	37± 05

TABLE 3
THE VARIABILITY OF PAIR DIFFERENCES

	1		2		3	
	Obtained*		Chance expectation		$\frac{\text{Obtained S.D}}{\text{Chance S D}}$	
	Like sex	Unlike sex	Like sex	Unlike sex	Like sex	Unlike sex
S D$_{ht\ diff.}$	1 03	1.35	1 89	1.80	54	75
S.D $_{wt.diff}$	1 23	1.55	2.37	1 95	.52	79
S.D$_{ht.-wt\ diff}$	86	1 20	1 73	1 50	50	.80

*For the sake of precision these values were calculated from the scores, not from the formula for the S D. of the difference

If the assumed S.D.'s of trait distribution derived from Baldwin, in terms of which the standard scores are expressed, had been the same as those of the experimental population, then the expected S.D.

of trait difference for chance pairing would have been $\sqrt{2}$, or 1.41. But our sample of 278 children showed a considerably greater dispersion (Table 1). The S.D.'s obtained by Gray and Ayers are somewhat smaller for height and larger for weight than those derived from Baldwin (Table 5), and in comparison with Baldwin's figures they are relatively larger for girls than for boys for both height and weight. From the S.D.'s of Table 1 the chance expectation is calculated for the S.D.'s of the differences and given in Table 3. If complete similarity existed in each pair the S.D.'s would be zero. The S.D.'s (Table 3, column 3) lie between chance expectation and zero. The values in both height and weight are relatively nearer zero for twins of like sex than for twins of unlike sex. This is what we might expect if monozygotic twins were present.

Both groups show strong familial resemblance between pairs. The degree of resemblance in the twins of unlike sex should correspond to that of siblings of like or unlike sex and of dissimilar age, unless external conditions affecting twins at the same age tend to make twins more alike than ordinary siblings. The study of sibling differences would serve as a control check for the present study.

THE S.D. OF THE DIFFERENCES BETWEEN MONOZYGOTIC PAIRS

The S.D. of the score differences of like-sex pairs is approximately half chance expectation both for height and weight (Table 3, Column 3). It is within this group that we assume the existence of monozygotics. The S.D. of the score differences of unlike-sex pairs is approximately three-fourths chance expectation both for height and weight. In this group we assume that there are no monozygotics. Knowing the S.D. of the score difference for dizygotic twins, namely, the unlike-sex group, and the S.D. of the score difference for the mixed monozygotic and dizygotic twins, namely, the like-sex twins, we may solve for the S.D. of the score difference of the monozygotic twins. If we assume that monozygotics comprise half of the group of like-sex twins, then, all means being zero,

$$\sigma^2_{mo} = 2\sigma^2_{l} - \sigma^2_{u},$$

where *mo* are the monozygotics, *l* the like-sex twins, and *u* the unlike-sex twins. For height $\sigma^2_{mo} = .144$, but for weight and for height minus weight we get values of $\sqrt{-.08}$ and $\sqrt{-.14}$. These latter are impossible as the S.D. of the monozygotics can not be less than zero. Either our like-sex group contained more than half monozygotics, or certain errors operated to make the apparent differences between the unlike-sex pairs greater than the actual differences. The sources of error are discussed later.

Out of 112 twin births, 41 were monochorionic and 71 diochorionic according to Klein's observations. If, accordingly, we assume that there exists in our sample of like-sex twins monozygotics and dizygotics in the ratio of one to two, then

$$\sigma^2_{mo} = 3\sigma^2_l - 2\sigma^2_u$$

This makes matters still worse.

If we assume that no error exists in the measurements or in the M's and S.D.'s of the traits that were derived from Baldwin's results, we may calculate the proportion of monozygotics to dizygotics in our like-sex twin group that would make these results possible.

As, $(n_{mo}+n_{di})\sigma^2_{mo+di} = n_{mo}\sigma^2_{mo}+n_{di}\sigma^2_{di}$

then, if $\sigma_{mo} = 0$

$$n_{mo} = \frac{n_{di}\sigma^2_{di}}{\sigma^2_{mo+di}} - n_{di}$$

where *mo* are monozygotics and *di* are dizygotics. Substituting the S.D.'s of Ht-Wt (Table 3, column 3, line 3) which, to be possible, demand the greatest proportion of monozygotics,

$$n_{mo} = 1.56\ n_{di}$$

That is, even if there were no pair differences in the height-weight pattern of the monozygotics they would, in order to satisfy the equation, constitute 61% of the like-sex twins. This is remotely possible, especially as the twins were brought to the laboratory as a result of newspaper publicity. Maternal pride and interest are to some extent proportional to the similarity of the twins, and it may well be that our population was somewhat selected on the basis of likeness of the pairs.

The important point is, however, that the differences between the monozygotics, although certainly not zero, are probably very much smaller than the differences between the dizygotics. If this rule holds for traits in general, we may anticipate statistically what the result would be if the differences in a *number of traits* for each pair in a population of like-sex twins were summated.

If we disregard the signs of the differences, as we must in adding together a number of differences, the mean difference of a trait for each species will be the mean deviation of its differences. The S.D. will be proportional to the mean (approximately .75M). If all the mean trait differences for each species were equal, and if the traits were not correlated, the mean of the summation of trait differences would increase as the number of traits, but the S.D of the summation of trait differences would increase as the square root of the number of traits

The distribution of these summations for like-sex twins would necessarily be dimorphic The greater the number of traits measured, the greater the tendency would be toward complete separation of the two species With such separation we would have an instrument for diagnosing any pair as monozygotic or dizygotic

If the traits were uncorrelated, and if the monozygotic means of the score differences of all the traits were equal, in terms of standard score, and if all the dizygotic means were equal, and if, for example, a dizygotic mean were ten times a monozygotic mean, then the summation of the pair differences of two traits would give a difference between the means of the two species that would be 1.5 times the sum of the S D.'s of the score differences of the two species. Using 10 traits in the summation, the difference would be 3 5 times the S.D.'s of the two species.

That is, for the traits separately,

$$M_{mo} = 1,\ M_{dt} = 10,\ \sigma_{mo} = .75,\ \sigma_{dt} = 7.5$$

Then for 2 traits

$$M_{mo} = 2,\ M_{dt} = 20,\ \sigma_{mo} = .75\sqrt{2}\ ,\ \sigma_{dt} = 7.5\sqrt{2}$$

$$D = 18,\ \sigma_{mo}+\sigma_{dt} = 11.63,\ \frac{D}{\sigma_{mo}+\sigma_{dt}} = 1.5$$

And for 10 traits

$$M_{mo} = 10,\ M_{dt} = 100,\ \sigma_{mo} = .75\sqrt{10}\ ,\ \sigma_{dt} = 7.5\sqrt{10}$$

$$D = 90,\ \sigma_{mo}+\sigma_{dt} = 25.56,\ \frac{D}{\sigma_{mo}+\sigma_{dt}} = 3.5$$

For these values of M the summation of 10 traits would give so complete a separation of the two species that .999 of like-sex twins could be diagnosed as monozygotic or dizygotic according as they fall into one or the other distribution. With the summation of more traits the differentiation of the two species becomes more and more reliable

If the means of the score differences in the several traits are not equal, the S.D of the summation is, of course, relatively larger.

The greater the intercorrelation of the several traits the larger is the S D of the summation for each species. If all intercorrelations were 1, no dimorphism would result from summating the traits. It is therefore desirable to select uncorrelated traits for measurement. There are ways, however, in which correlated traits may be used to advantage, but it is their relation and not their separate measures that must enter into the summation.

THE USE OF CORRELATED TRAITS

Hair color and eye color, or height and weight, or arithmetical and reading ability, are correlated traits, so that the prediction of one is improved when we know the other. Hair color and weight, or height and reading ability, or arithmetical ability and eye color, are not correlated traits. If the traits selected for measurement in the determination of pattern resemblance are all uncorrelated, then the summation of a relatively small number of pair differences in terms of standard score would give us a satisfactory coefficient of similarity in form or pattern. But if the traits are correlated, as in the case of height and weight, we must preserve the signs of the differences if we are to utilize their full significance. The difference in height and the difference in weight of a pair of twins is not always in the same direction The taller twin may be the lighter in weight. The differences may be of the same magnitude but of opposite sign.

When two correlated traits are to enter into the determination of pattern resemblance, we may preserve the signs and find the difference of the two trait differences. The smaller this value is the more alike in pattern are the members of the pair. A better method, however, is to determine the ratio of the raw scores (e.g, pounds divided by inches) for the general population and to express the differences in terms of the S.D. of the age and sex groups' distributions of these ratios. A difference so stated for the two traits combined is more significant than that for either trait taken separately and may enter into the summation of uncorrelated traits. If the correlation between traits is very low the labor involved in such a procedure might be unjustified and the separate trait differences could be included in the summation.

For the statistical differentiation of monozygotics and dizygotics in a population of like-sex twins we would, then, select for measurement traits that show little or no correlation among themselves If we wished to include pairs of correlated traits we would express the raw measures as ratios. The differences between the pairs of twins in each of the traits would be expressed in terms of the S D. for age and sex Traits would be measured until the distribution of the summation of differences showed a degree of dimorphism that would satisfactorily assign any pair to one species or the other.

SOURCES OF ERROR

A certain degree of correspondence in terms of standard score is to be expected between measurements of boy-girl pairs when growth is completed. This correspondence might be less prior to the completion of growth because of a different acceleration of growth in boys and girls. Familial resemblance might then be greater in the early years in like-sex dizygotics than in unlike-sex dizygotics The use of standard scores should correct for this irregularity, but it may not do so completely.

Weight is a more complex trait than height and depends upon a larger number of factors For this reason we would expect, and we find, less familial resemblance in weight than in height The individual varies more in weight from day to day than he does in height. On the other hand, height measures are less reliable than weight measures A single measure of either trait is hardly representative of the individual.

In the case of twins of unlike sex there are several sources of error that increase their differences, as measured, beyond their real differences. First, boys and girls are separately scored with reference to their own age-sex means in the norm tables, and, unless the error of deviation of the means of the norm tables from the true means for each sex is in the same direction and of the same degree, the obtained pair differences are larger than the true differences This is not the case with twins of like sex. Second, if the S D.'s that were used as scale units (Table 4) deviated for boys and for girls in different directions from the true S D.'s at any given age, the obtained standard score pair differences would be more variable and would tend on the average to be slightly greater than the true

TABLE 4

THE STANDARD DEVIATIONS USED AS SCALE UNITS (INCHES AND POUNDS)

Ages'	6½	7½	8½	9½	10½	11½	12½	13½	14½	15½	16½
Boys' height	1.7	1.8	1.8	1.8	1.9	1.9	1.9	2.0	2.1	2.1	2.1
Girls' height	1.2	1.3	1.3	1.4	1.6	1.8	1.9	2.0	1.9	1.9	1.8
Boys' weight	4.2	4.6	5.3	6.5	7.7	9.2	10.7	11.8	11.6	11.4	10.9
Girls' weight	4.0	4.4	5.1	5.8	6.7	7.4	8.4	9.7	11.1	11.3	10.4

differences A third source of error exists in that the children were weighed with their clothing, except that shoes, coats, and sweaters were removed. In the case of twins of like sex this added an almost constant increment to their actual weight. Twins of unlike sex probably wore clothing of different weight and this tended to make the observed differences greater than the true differences

Although the age range of both like-sex and unlike-sex groups is the same, the unlike-sex twins were on the average older (Table 1). From Table 5 it would seem that as the like-sex group grows older

TABLE 5

AGE VARIATION IN MEAN DEVIATION OF PAIR DIFFERENCES

	Height difference				Weight difference		Ht diff.-Wt. diff	
	Like sex		Unlike sex		Like sex	Unlike sex	Like sex	Unlike sex
Age	N	M.D	N	M.D	M.D.	M D	M D.	M D
6-10	38	.72	18	97	77	81	66	88
11-16	31	.66	52	1.16	.96	1.39	.53	97
6-16	69	.69	70	1.11	85	1.24	60	94

the pair members come to resemble each other more in height and in height-weight pattern, although their weight resemblance decreases somewhat with age. Compared with these, the unlike-sex pair members show a relatively greater decrease in similarity in both traits as age progresses The difference in mean age of the two groups might seem to be a disturbing factor, but it is evident that if this age variation of M.D.'s is characteristic in general, and if our twins of like sex had been as old as those of unlike sex, the differences between the two groups would have been greater than those we have obtained. The implication is that the older the samples are the greater is the divergence of the two groups in degree of pair similarity

The reliability of the raw measures is probably as high as is ordinarily obtained, as they were taken with the utmost care by trained observers A small error of random sampling fluctuation is of course present. The differences, however, between the like-sex and unlike-sex groups are far too great to be attributed to any or all of the above-mentioned sources of error.

SUMMARY

1. The like-sex twins were found to be taller and of slighter build than the unlike-sex twins.

2. There is the same degree of individual height-weight pattern variability in the populations of like-sex and of unlike-sex pairs.

3 There is far greater resemblance between the pairs of like sex than between the pairs of unlike sex, both in height and in weight.

4. The pairs of unlike sex show slightly more resemblance in height or weight taken separately than they show in height-weight pattern The reverse is true for the pairs of like sex, who show slightly more resemblance in height-weight pattern than they show in height or weight taken separately.

5. The results are what we would expect if monozygotic twins exist among twins of like sex

6 In the like-sex pairs, similarity in height and in height-weight pattern increases slightly with increase in age, whereas weight similarity decreases. In the unlike-sex pairs, similarity in height, weight, and height-weight pattern decreases with increase in age

7 The S.D. of *pair differences* in the monozygotics may be statistically determined for any trait if we know the S D. for the like-sex twins and for the unlike-sex twins In height or weight the monozygotic S D. is very much smaller than the dizygotic S.D.

8. The summation of pair differences in many uncorrelated traits in a population of like-sex twins must necessarily give a dimorphic distribution that would designate any pair as monozygotic or dizygotic.

9. The sources of error are listed.

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Y A-T-IL DEUX ESPÈCES DE JUMEAUX?

(Résumé)

La variabilité des différences entre les paires parmi les jumeaux monozygotes est statistiquement isolée par une comparaison des différences entre les paires parmi les jumeaux du même sexe et ceux non pas du même sexe. Puisque les différences monozygotes sont beaucoup plus petites que les différences dizygotes, il suit de là que la sommation des différences entre les paires en termes des résultats étalons dérivés des traits non correlés chez un groupe de jumeaux du même sexe montrerait un dimorphisme qui servirait de moyen de distinguer les paires monozygotes et dizygotes.

SMITH

GIBT ES ZWEI ARTEN VON ZWILLINGEN?

(Referat)

Die Verschiedenheit der Paarunterschiede unter monozygotischen Zwillingen wird statistisch durch den Vergleich der Paarunterschiede unter den gleichen und ungleichen Geschlechtern bei den Zwillingen isoliert Da die monozygotischen Unterschiede weit kleiner sind als die zweizygotischen Differenzen, folgt es daraus, dass die Summierung der Paarunterschiede in Bestimmungen des Normalwertes, die von den unkorrelierten Eigenschaften in einer Gruppe der gleichen Geschlechter erhalten wurden, einen Dimorphismus zeigen würden, der als Mittel zur Unterscheidung der monozygotischen und zweizygotischen Paare dienen würden

Smith

THE PRINCIPLE OF SPECIFIC CONDITIONERS*

From the Department of Psychology of the University of Washington

Stevenson Smith

In 1930 Guthrie published "Conditioning as a Principle of Learning" (2), in which he showed that the factor of proprioceptive conditioning is often overlooked in the explanation of such behavior changes as improvement with practice, inhibitory conditioning, irradiation, trace reflexes, experimental extinction, and forgetting. Two years later Sheldon (3) reported some results of maze learning which she could not explain in terms of Guthrie's analysis. This was not surprising as she had quite failed to understand what Guthrie had so clearly said. Her misinterpretation, and her failure to get from the laboratory what she supposed Guthrie would have expected, influenced Bellows (1) in 1933 to say that Guthrie has "modified the Pavlovian concept of conditioning further, in the hope of clarifying the problem of mental development" (i e., learning). "Guthrie emphasized the proprioceptive sense organs as conditioners. He has a highly plausible theory of the physiology of learning. However, a preliminary experiment by Sheldon appears to reflect doubt on this hypothesis "

Guthrie's analysis is so important to the psychology of learning that it is necessary to point out that Sheldon's comments on Guthrie's article are inapplicable and that she tested a hypothesis that Guthrie never proposed

Sheldon begins her discussion by saying that the principle of the conditioned reflex is not a complete explanation of learning This may seem to be a platitude, but it is a point that has sometimes been neglected. Even if all houses were built of wood, the predication of wooden construction would not adequately describe a house. Sheldon says that Guthrie has attempted to modify the conditioned-reflex theory so as to meet the objection that conditioning is not a complete explanation of all learning. Guthrie's modification, she says, has been

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*Accepted for publication by Carl Murchison of the Editorial Board and received in the Editorial Office, October 18, 1934

to lay a greater emphasis on the rôle of the proprioceptive sense organs as conditioners in the learning process. This, of course, constitutes no modification of the conditioned-reflex theory. Guthrie proposed none.

What Guthrie did say in his discussion of the law of frequency was that the increased certainty of response to a given stimulus situation which so often follows repetition may be explained by the fact that new conditioners, and especially new proprioceptive conditioners, are enlisted. Repetition in Pavlov's experiments may associate new postures with the salivary response until finally the dog is fairly certain to be caught in a practiced attitude and hence fairly certain to respond. The response in this case is the secretion of saliva. Many postures may become associated with this single response, thus rendering its occurrence more likely. Sheldon has by implication inverted the thesis to read: a *single* postural pattern may become associated with *many* responses, thus rendering more likely the occurrence of each of the responses at its appropriate time This neither follows from what Guthrie said nor is it true.

Sheldon's experiment was to use two groups of subjects in stylus maze learning. One group learned the maze with a stylus that moved with normal friction through the pathways. The other group learned the same maze with a stylus that had to be moved along the iron floor of the runways against a friction actuated by an electromagnet that the stylus contained The group working against greater friction obviously had to make stronger and more diffuse muscular contractions than had the other group No marked difference in learning was shown between the two groups in the mean number of trials necessary to learn the maze. The friction group made considerably more errors, however, than did the non-friction group. In relearning, the friction group required slightly fewer trials than the non-friction group, although the difference is not highly significant. The author is justified in her conclusion that the greater muscular effort, or the correspondingly greater number of proprioceptors stimulated, does not seem to aid in learning insofar as the conditions of her experiments might reveal this. Indeed, such aid would not be expected.

Maze learning and correct maze running are serial responses. A serial response may be analyzed into its component stimulus-pattern and response-pattern connections. Proprioceptive stimulation, nearly always movement-produced, will serve to bring about particular responses only insofar as each sense-organ pattern is specially reserved for each response pattern. A mere increase in the number of sense organs stimulated, unless this increase results in greater diversity of the several sense-organ patterns, will not have the effect of calling out the particular responses in their proper order.

Suppose we were to say that the more visual cues we get, the more readily we learn our way about This is true if taken in the ordinary sense, that is, if taken to mean that the more differentiated the visual spacial patterns are, the better we learn our way about A mere increase in illumination, unless it serves to give us more variety of successive stimulus patterns, will not help our learning. It may have quite the reverse effect, for, if the illumination is intense enough to reduce the pattern differences, or to force us to make movements incompatible with finding our way about, it interferes with learning.

An increase in the number of sense organs stimulated is of no selective aid to learning if this increase is simply the addition of the *same* stimuli to each of the already present groups of specific conditioners. Such an increase sometimes acts as a reenforcement and sometimes acts as a distraction. A greater number of leaves on all the trees does not help us to remember the trail through the woods. The easiest trail to learn is one that shows progressive diversity, and the easiest trail to remember is one that is rich in diverse cues.

So also with proprioceptive cues. A man with a trunk on his back will probably not learn to run a maze more quickly than he would without such a burden, even though carrying the trunk will result in the stimulation of more proprioceptors. But if each part of the path provides its own special stimulus pattern for the proprioceptors, or for any other sense organs, a conditioning to this pattern of the "correct" turn at each point of choice is to be expected. The specificity of a response must always depend upon an order and combination of receptor stimulations that is reserved for that response alone.

Those of Sheldon's subjects who had to overcome added friction in the maze certainly stimulated more of their proprioceptors than did the "control" group. But as any movement, north, east, south, or west, was followed sometimes by a right turn and sometimes by a left turn, any added proprioceptive stimulation, being at different times the antecedent of each of two directionally opposite movements, would never become the cue for either turn. It is under these circumstances that inhibitory conditioning occurs.

If Sheldon could have taken the precaution to keep constant the distance and direction of the subject's body with reference to the maze, it is possible that increased mass stimulation, not peculiar to any succeeding *directional* response, might have favored learning. With such a precaution general bodily posture might correspond sufficiently with hand position in the maze to allow increased muscular effort to provide additional specific cues. But with the necessity for increased muscular effort the subject is more likely to shift position and probably the attempt to keep distance and direction constant would not be practicable.

THE PRESENT EXPERIMENT

With the principle of specific conditioners in mind, a stylus-maze learning experiment was conducted in which the mazes had two kinds of floors, one plane and the other uneven. The irregular surface of the uneven floor was produced by milling out depressions of random occurrence and depth from a brass floor plate. There were two maze patterns (*A* and *B*), each of which had two floors, plane and uneven (*P* and *U*). This gave four mazes, *AP, AU, BP,* and *BU* In *AU* and *BU* the random unevenness of the floors provided specific proprioceptive patterns that might serve as specially reserved cues for each turn

Forty subjects were used Ten practiced mazes *AP* and *BU* in that order. Ten practiced *BU* and *AP,* ten practiced *BP* and *AU,* and ten practiced *AU* and *BP* This made it possible to introduce an empirical correction for relative difficulty of maze patterns *A* and *B,* as well as an empirical correction for practice effects, as practice in the first maze improved performance in the second. Performances on plane and uneven floors (*P* and *U*) were then treated as correlated measures.

The maze units were one inch in length. Blinds of similar length were at right angles to the path. A spherical depression into which the stylus sank occurred at intervals of one inch. These corresponded to the points where the path and blinds branched. At intervals of

1.5 seconds a buzzer signal was sounded. The subject traversed one inch of maze, either true path or blind, for each 1.5-seconds time interval. By this method the *distance* traversed along the correct path in a given time became a measure of learning. A subject spent fifteen minutes of working time on each of his two mazes. Thus, if he had made no errors, his distance score would have been 600 inches. On reaching the goal his stylus was placed back at the starting point with no more delay than necessary After fifteen minutes of actual work on the first maze, the second maze was placed in position and work was again begun. No mention was made of the plane and uneven floors. Before being blindfolded for the experiment the subject was given a plane-floored practice maze on which he learned to keep time with the signal.

The handle of the stylus was set at a right angle to the vertical shaft and was shaped for grasping. The end of the stylus was spherical and three-sixteenths of an inch in diameter. The width and depth of the alleys was one-fourth inch.

Maze patterns *A* and *B* were composed of the following one-inch directional units (Forward, back, right, and left are indicated by F, B, R and L. The blinds are indicated by parentheses Some of the units had no blinds).

Pattern *A*. L(L)—B(R)—L—L(L)—F(L)—F(L)—R(FL)—R—F(F)—R(B)—F—F(F)—L(L)—F—L—L(L)—B—B(R)—L(B)—F—L(F)—L(F)—B(B)—R—B—B(L)—B(B)—L—B

Pattern *B*: L(L)—F(L)—F—F(R)—L(B)—F(R)—F(F)—R—R(B)—F(L)—R(B)—R(B)—R(R)—B—B(L)—R(F)—B(B)—L(B)—L—L(F)—B(L)—B(L)—R(F)—B(L)—R(R)—F—R

RESULTS

Each subject worked on two mazes The order and combination of the four mazes, two at a time, are shown in Table 2 The score corrections for practice and for relative difficulty of pattern are given in Table 1. The "corrected" scores in Table 2 are all in terms of the difficulty of maze pattern *A* when practiced first

The uneven floor, intended as it was to serve as a specially reserved proprioceptive cue in each maze unit, actually served to a great de-

TABLE 1

SCORE CORRECTIONS FOR ORDER OF PRACTICE AND PATTERN DIFFICULTY

Mazes	Mean score	Correction ratio
Practiced first	164.150	
Practiced second	240.475	6826
Pattern *A*	181.950	
Pattern *B*	222.675	8171
Pattern *B* practiced second		5578

TABLE 2

DISTANCE SCORES WITH PAIRED MAZES

Maze	Raw score M	Raw score σ	Correction	Corrected M	Corrected σ
AP	141.9	50.70	1.0000	141.9	50.70
BU	261.6	82.65	5578	145.9	46.10
BP	167.7	64.28	8171	137.0	52.52
AU	219.1	105.93	6826	149.6	72.31
BU	192.1	75.98	8171	157.0	62.08
AP	211.9	108.11	6826	144.6	73.80
AU	154.9	43.80	1.0000	154.9	43.80
BP	269.3	77.67	5578	150.2	43.32

TABLE 3

COMPARISON OF CORRECTED DISTANCE SCORES IN PLANE AND UNEVEN FLOORED MAZES

Maze	N	M	σ
Plane floor	40	143.425	56.44
Uneven floor	40	151.850	57.45

r_{pu} = 69, σ_{diff} = 7.12, Diff = 8.425, P = 883

gree to hamper the subject in finding the inch-apart stopping holes. If this distraction could have been eliminated the rate of learning on the uneven surface would probably have been faster. In spite of this hindrance the effect of the uneven floor was favorable to learning.

Although the difference in performance on the plane and uneven floors is not above suspicion, it is nevertheless fairly significant. As shown in Table 2, the added proprioceptive cues favored learning for the subjects in each one of the four subgroups. Each subgroup was made up of ten subjects.

Certainly no differential reaction is possible to identical stimulus patterns The learning of the ordinary maze, whose points of choice are not supplied with specific cues, is made possible because we bring our own specific cues to each point of choice. These are postural sets or some bodily condition with which our progress up to that point has provided us When specific, objective cues at points of choice are added to these cumulative bodily changes we are thereby assisted in learning a maze pattern. We are engaged throughout in responding to both the cumulative cues and the local cues. But to be adequate, the cues must be specific. That the form of response varies dependently with the stimulus pattern is a principle which in no way denies the influence of "central" factors.

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DAS PRINZIP DER SPEZIFISCHEN BEDINGER

(Referat)

Die Ergebnisse dieses Experiments deuten an, dass das propriozeptive Reizgebilde als Fingerzeige zum Labyrinthlernen dient Um aber wirksam zu sein, mussen die Reizgebilde fur jede Form der Antwort verschieden sein Das Prinzip der spezifischen Bedinger wird dadurch gekennzeichnet, dass identische Reizgebilde nicht unterschieden werden konnen und dass Differentialreaktionen abhangig vom Reizgebilde variieren

SMITH

LE PRINCIPE DES FACTEURS CONDITIONNELS SPÉCIFIQUES

(Résumé)

Les résultats de l'expérience rapportée indiquent que les formes proprioceptives du stimulus servent de repères pour l'apprentissage du labyrinthe. Pour être effectives, cependant, il faut que les formes du stimulus soient différentes pour chaque forme de réponse Le principe des facteurs conditionnels spécifiques est que les formes identiques du stimulus ne peuvent être discriminées et que les réponses différentielles varient dépendamment avec la forme du stimulus

SMITH

SKILL AND PROPRIOCEPTOR PATTERN*

From the Department of Child Welfare of the University of Washington

STEVENSON SMITH AND ESTHER E FITCH

The experiment here reported concerns (1) the rate of learning to respond adequately when postural cues are artificially distorted, and (2) the duration of the habits that have been learned under the distorted conditions when the subject is returned to normal conditions. The act employed was throwing darts at a vertical strip and the distortion of postural cues was effected by the use of prisms in spectacle frames

The target was 42 inches high and 42 inches wide, placed 34 inches from the floor at a distance of 12 feet. Dividing a white field into two lateral halves was a two-inch vertical black strip at which the subject aimed. Only his lateral deviations from this line were measured Distances in units of two inches from the black strip were indicated by faint vertical lines that were hardly visible to the subject.

The dart was 11 inches long, constructed of a cedar shaft 5/16 inches in diameter that terminated in a pear-shaped iron tip from which a phonograph needle protruded. The rear end was feathered with three strips of celluloid The dart balanced near the tip at a convenient place for grasping.

Two 8-diopter toric prisms were mounted in a spectacle frame around which was fastened a secondary frame made of spring brass. Around the outer edge of the secondary frame were small holes to permit the sewing on of a mask of double thickness black satin. This mask was tied behind the subject's head and padded with cotton below the eyes so as to exclude all light except that which entered through the prisms. The secondary frames formed two circular apertures or diaphragms of 1.25 inches diameter. The distance between the centers of these openings was 2 5 inches. This was approximately the average interocular distance of the subjects used. The mask and frame cut off any sight of the throwing arm

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*Accepted for publication by Carl Murchison of the Editorial Board and received in the Editorial Office, September 18, 1934

An inch-high peg of wood was fastened to the floor to indicate to the subject his proper distance from the target. This gave him no directional cues. The target was illuminated in an otherwise dark room by a light from above that was screened from the subject's eyes.

Five darts at a time were placed in the subject's hand in semi-darkness He held the extra darts in the hand not used for throwing He had first been allowed to examine the dart in the light and had been instructed as to the best way in which to hold it He was then told to take his place and to hit the black line with the darts. No practice throws were allowed.

Seventy-five male college students were used as subjects. All but two were right handed Most of them had never worn glasses and none had any serious refractive error. Those who wore glasses discarded them for the experiment.

A subject's first twenty throws were made without prisms His second twenty throws were made while wearing the prisms. His third twenty throws were made after removing the prisms. The use of prisms deflects the axis of vision when an object is fixated and thus would make the object appear displaced if it were reached for. Under the conditions of the experiment, however, there was no cue prior to throwing that gave the target any appearance of being displaced While the prisms are worn, a rotation of the head about the axis of vision results in a slight distortion of the image even when toric lenses are used, but this does not serve as a directional cue None of the subjects knew that he was wearing prisms and each was warned not to look at his darts or his hands while preparing to throw.

As the experiment progressed it became apparent that the subjects showed a constant error of throwing to the right during the first twenty throws, although this almost disappeared before the end of the first twenty throws This may have been owing to the subjects' overestimating the distance to the target; possibly it resulted from the way the subjects tended to grasp the unfamiliar dart; or it may have been a function of throwing from the right of the point of observation. In order to compensate for this constant error, thirty-five of the subjects, approximately half of them, were given their practice with the prisms placed so as to deflect the eyes to the right and the remaining forty had the prisms reversed, so that the eyes were deflected to the left.

The mean deflections given in the accompanying table for throws with prisms and for throws after prisms were removed are half the difference between the mean deflections of the two groups. This compensates for the right throwing tendency and states the deflections

TABLE 1

Preliminary			Prisms worn			Prisms removed		
Throws	M	S D	Throws	M	S D	Throws	M	S D
1	5.86	6.25	21	7.34	4.24	41	5.13	4.21
2	2.85	5.79	22	5.66	3.87	42	4.84	4.29
3	1.62	5.21	23	4.80	3.84	43	3.44	3.70
4	1.76	4.88	24	3.97	3.87	44	3.77	4.18
5	1.62	4.53	25	3.58	4.29	45	1.91	3.91
6	.92	4.57	26	2.92	3.69	46	2.18	4.20
7	.98	4.16	27	2.87	4.15	47	2.19	3.16
8	.79	3.58	28	2.48	4.16	48	1.50	4.66
9	.68	3.19	29	2.09	3.62	49	2.13	3.58
10	.33	3.40	30	2.63	3.97	50	1.39	3.87
11	1.33	4.31	31	2.64	3.88	51	.73	3.73
12	.64	3.21	32	1.95	3.28	52	1.30	3.72
13	.29	4.18	33	1.00	3.84	53	1.01	3.94
14	.07	4.20	34	1.78	3.54	54	.91	3.18
15	.31	3.98	35	1.44	4.05	55	.40	3.82
16	.53	3.86	36	1.43	3.94	56	.65	3.52
17	.96	3.30	37	1.48	3.81	57	.54	3.78
18	— .43	4.21	38	1.80	3.98	58	1.13	3.22
19	.77	3.52	39	.87	3.34	59	1.14	3.36
20	.33	3.57	40	1.79	3.79	60	.91	3.81
Pooled			Pooled			Pooled		
1- 4	3.02	5.53	21-24	5.44	3.95	41-44	4.30	4.09
5- 8	1.08	4.21	25-28	2.96	4.07	45-48	1.95	3.98
9-12	.74	3.52	29-32	2.33	3.69	49-52	1.39	3.72
13-16	.30	4.05	33-36	1.41	3.84	53-56	.74	3.61
17-20	.41	3.65	37-40	1.48	3.73	57-60	.93	3.54
1-10	1.74	4.56	21-30	3.84	3.97	41-50	2.13	3.98
11-20	.48	3.83	31-40	1.62	3.74	51-60	.87	3.61
1-20	1.11	4.19	21-40	2.73	3.85	41-60	1.86	3.79

The S.D.'s of the pooled throws are the averages of the S.D.'s of the component throws.

The means of throws 1-20 are of deflections to the right.

The means of throws 21-40 are of deflections in the direction of the deflected axis of vision.

The means of throws 41-60 are of deflections away from the direction of the previously deflected axis of vision.

of the throws without reference to right or left and only with reference to the direction in which the eyes were deflected. The unit of measure in the table is one inch.

The constant error of throwing to the right is seen when we compare the scores of the subjects whose throws were forced to the right with those of the subjects whose throws were forced to the left. The mean of all the throws of the former when wearing prisms was 3.16 inches to the right, and the mean of the latter when wearing prisms was 2.30 inches to the left. The constant error for both groups combined, then, was .86 inches to the right. The means of the two groups for all the throws after prisms were removed were respectively 1.06 inches to the left and 2.66 inches to the right, with a constant error to the right of 1.60 inches. These constant errors were, of course, eliminated by the reversal of conditions for the two groups of subjects and by the method of computing the mean deflection of the total group for each of the sixty throws.

When the eyes are laterally deflected by prisms (throws 21-40) the subject tends to throw to the corresponding side, and the dart hits wide of the mark. This is because of a lifetime of conditioning of the motor response to the postural pattern that is imposed by the degree of tension of the subject's eye muscles and the position of the rest of the body. With continued throwing the subject, seeing his error, corrects for this tendency so that finally he throws almost as accurately as he did before putting on the prisms. When he removes the prisms, and continues to throw (throws 41-60), his darts strike on the side opposite to that toward which the prisms had previously deflected his eyes. This is because he had learned, while wearing the prisms, a new set of responses to postural patterns. Just as his error while wearing the prisms is a measure of all his past learning, so his error after removing the prisms is a measure of learning during the previous twenty throws. It will be seen from Table 1 and Figure 1 that the effect of the immediately preceding twenty throws under distorted conditions (throws 21-40) is two-thirds as great (68 per cent) as was the effect of the subjects' life-long practice under normal conditions.

The fact that the subjects did not wear the mask during throws 1-20 and throws 41-60 possibly made that practice a little more effective than practice while wearing prisms and mask during throws

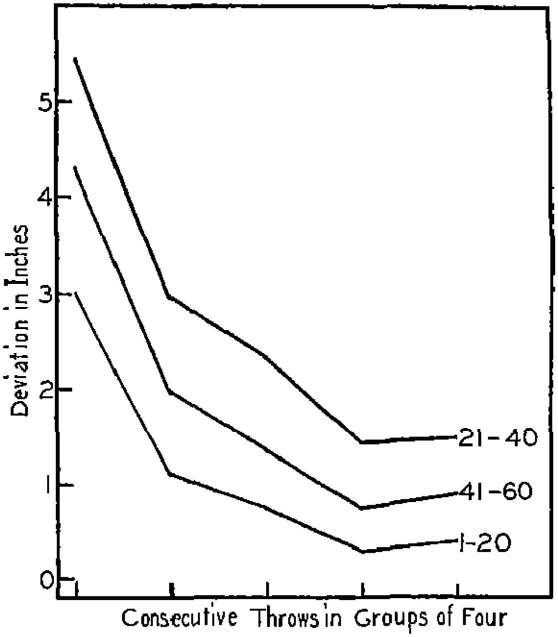

FIGURE 1

21-40. To be able to see the throwing arm in peripheral vision is probably a help in throwing accurately. With the mask off, the moving hand could be seen dimly even in the semi-darkness of the room. If this factor operated, it resulted only in an underestimate of the after effects of wearing the prisms.

In the accompanying graph there is seen a remarkable similarity in shape of the learning curves for preliminary practice, practice with prisms, and practice after prisms were removed. No explanation is offered for this other than to say that it probably represents a regular pattern in the degree of improvement with practice under the conditions of this experiment. Certainly the shape of the curves is not an artifact resulting from any constant variation in laboratory conditions. There is, for example, no periodicity corresponding to the number of darts the subjects held in their hands. The common shape of the curves must represent the progress of learning in each of the three problems as it is determined by the interaction of the subjects' previous habits and their observation of the results of their throwing

THEORETICAL DISCUSSION

Any skill that deals with external objects is made up of movements that depend upon postural cues. In throwing at a target it is not the visual stimulus pattern but the proprioceptor pattern that determines the appropriate muscular coordination. The visual pattern will be approximately the same for all body positions because the thrower is fixating the target. If the target is at a constant distance, and isolated from other visual cues, the thrower's feet may be pointed in various directions, necessitating a corresponding variety of motor coordinations in throwing, and the target will be hit from one stance about as well as from another The stimulus pattern stream, specifically reserved for each kind of throw, is furnished by posture. The visual pattern merely enables the thrower to anchor his eye Anchoring the eye establishes the posture and the proprioceptor pattern to which the thrower has learned to respond in the appropriate way. There is almost certainly no innate neural mechanism for throwing at, or reaching toward, objects that are seen.

The movements of a skilled act are determined by all the movement-produced stimuli that the act causes. These stimuli constitute a changing pattern from beginning to end of the act In throwing, each subsequent bit of movement is conditioned to the preceding postural pattern. We should not, of course, think of the changing stimulus pattern and the changing movements as made up of "steps." The changes are continuous The stimulus stream and the movement stream are caused each by the other. In most skills the sight of the moving hands, in their relation to the objects about us, constitute an important part of the stimulus stream. It is these visual stimulus patterns, warning us as they do of impending errors, that best cause us to eliminate blunders. If we see the results of our action only after our act is finished, as in shooting a revolver from the hip, the development of accurate movement is slower If we never know the results of our action we show no improvement in the act.

Correction of wrong movements when mediated by visual observation of results may result in part from verbalization. We may say, "next time a little more to the left," and this so changes our posture as to result in a better throw The observation of our error may also cause a shift of posture that is independent of language and that, carrying over to the next throw, will improve the act When, through continued practice, accuracy has become habitual, such verbalization as was present may be dropped out and the proper postural set will then be aroused by the sight of the target The final conditioning is then to proprioceptor pattern.

It is interesting that human beings adapt themselves so quickly to the distortion of a postural pattern by substituting a new movement pattern for the one so long practiced. It argues that the old stimulus and action patterns were associated through learning and not innately linked The instability of the connection is too great to allow any other supposition The results also suggest that forced changes in skills of this order of simplicity are very rapidly learned. The rotated visual field that Stratton and Ewert and his subjects learned to respond to necessitated a substitution of responses very different from those they habitually gave. In two-dimensional space the new substituted movements were directionally opposite to the old In the experiment here reported, as well as in the experiments of Wooster and of Brown, the substituted movements were not so unlike the old The significant fact, however, is that they were different

Verbalization plays its part in the relearning Adverse criticism of any learning experiment is likely to emphasize this point. But such criticism is called for only when it has been claimed that verbalization is excluded in the learning process. However mediated, the new conditioning persists in spite of verbalization that is directed toward overcoming it The throwing habits here reported are not in the end verbal habits.

The degree of persistence of the new conditioning after the distortion of the stimulus pattern had ceased is the most significant result of the experiment The previous conditioning from daily life which the subjects possessed before the experiment began, and which was added to by the first twenty throws, impeded the new conditioning that developed adaptively to the wearing of prisms With the removal of the prisms, and a return to normal postural pattern, the recovery of the old lifelong conditioning was impeded by the presence of the new conditioning about two-thirds as much as the establishment of the new conditioning had been impeded by the old.

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L'HABILETÉ ET LA FORME PROPRIOCEPTIVE

(Résumé)

On a mesuré les effets de l'exercice dans le lancement du dard (1) dans les conditions normales, (2) avec une forme de posture déformée comme résultat de placer des prismes devant les yeux, et (3) après qu'on a enlevé les prismes. On a constaté que les effets suivant l'emploi des prismes pendant 20 lancements ont été aussi grands des deux tiers dans la modifications des 20 prochains lancements que l'effet d'avoir jeté und dard pendant toute sa vie dans la modification de l'acte de lancer avec les prismes devant les yeux.

SMITH ET FITCH

GESCHICKLICHKEIT UND DAS PROPRIOZEPTIVE GEBILDE

(Referat)

Die Wirkungen der Übung auf das Werfen vom Wurfspeer wurden unter folgenden Umstanden gemessen. (1) unter normalen Umstanden, (2) mit Haltungsfingerzeigen, die infolge der Aufsetzung der Prismen vor die Augen verbogen wurden, und (3) nach der Abnahme der Prismen. Es wurde festgestellt, dass die Wirkung der Prismen fur 20 Würfe auf die folgenden 20 Wurfe zwei Drittel so gross zur Modifizierung der Wurfe mit den Prismen vor den Augen war wie die Wirkung einer lebenslangen Übung beim Speerwerfen.

SMITH UND FITCH

NEGATIVISTIC REACTIONS OF PRESCHOOL CHILDREN ON THE NEW REVISION OF THE STANFORD-BINET*

From the Department of Psychology of Stanford University

BARBARA A. MAYER

General growth of interest in the preschool child and widespread use of intelligence tests as experimental instruments in this field have brought an increasing concern with the observed factor of negativism, or resistant behavior Negativism aroused experimental interest at first because of its effect as a deterrent to securing the most successful test behavior, although the trait itself has long been recognized as a normal but undesirable manifestation appearing sometime during the child's early years. When incidental and then specific studies of the trait began to be made, widely different aspects were selected for experimental work

The factors which influence, produce, or cause negativism in a test situation as recently noted or studied group themselves into three chief fields· those relating to the child himself, to the type of test, and to the technique of administering the test The age of the child has been generally considered to be the most fundamentally associated variable, although there has been incomplete agreement upon the age at which negativism reaches its peak, and upon its proportional distribution over the age range The sex of the child has been considered, his condition at the time of the test, his social status, position in the family, his level of ability and relative ability, and his stage in the development of expression of his personality. In estimating the importance of the type of test, characteristics suggested are the amount of verbalization required, whether the child's attention is directed inward or outside of himself, whether the test causes the examiner to appear "within" or "without" the situation, and the difficulty of the test. In administering the test, the particular examiner, the surroundings, the procedure, the difference in demand for cooperation at different ages, and a number of other elements

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*Accepted for publication by Lewis M. Terman of the Editorial Board and received in the Editorial Office, September 11, 1934.

have merited note. The particular studies and their findings are well summarized by Reynolds (10) and Rust (11).

STATEMENT OF THE PROBLEM

The instruments that have been used in reports on negativism are, in the order of frequency of their use, the Kuhlmann-Binet, the Merrill-Palmer Scale, the Minnesota Preschool Scale, and situations specially devised to resemble test situations. The present study is based upon responses to tests included in the forthcoming new Revision of the Stanford-Binet.[1] It has as its purpose the investigation of the incidence of negativism, its distribution over the age range covered by "preschool" standardization, and the differing methods of its expression, examination into the specific tests and types of tests of the New Revision giving rise to negativism, and its relation to test difficulty, determination of the influence of negativism on test results; and incidentally, the relation of sex differences to, and the effect of test experience upon, negativism.

PROCEDURE

1. *Subjects.* The cases studied are included in the standardization of the new Revision, and were examined for that purpose between 1930 and 1932. This analysis includes all cases under six years tested by Mrs Melita H. Oden and the writer. These two examiners, having long cooperated in trying out the tests, were found to have used practically identical methods in their complete recording of the child's performance as well as his expression—a very important consideration in attempting to interpret data gathered for a different purpose The ages range from 18 months to 5½ years, the children being tested within 15 days of a birthday or of the midpoint between birthdays. Each child had been given Form L and Form M, with not more than one week elapsing between. The children all have American-born parents, and represent as nearly an unselected group as could be obtained in regard to social and economic factors. They were located through school siblings

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[1] The data on which this study is based were obtained during the course of the investigation by Dr Lewis M. Terman and Dr Maud A Merrill which was made possible by grants from the Stanford University Social Science Research Funds

in average schools also used in the standardization, through birth records; through the records of Health Centers; and six of the 4½-year-old children, 34 of the 5-year-olds, and 32 of the 5½-year-olds were attending kindergarten. The testing was done in school or clinic rooms, occasionally in homes, and in general under favorable conditions. Table 1 gives the distribution of subjects by age, location, sex, and first form.

TABLE 1

DISTRIBUTION OF CASES BY AGE, LOCATION, SEX, AND FIRST FORM

	San Francisco				Vermont				White Plains, New York, etc				Totals		
	L first		M first		L first		M first		L first		M first				
	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls	
1½ yrs.	5	5	5	6	1	3	1	3	1	0	1	0	14	17	31
2 yrs	4	2	4	4	1	3	1	3	2	0	0	1	12	13	25
2½ yrs	4	5	2	4	2	3	3	1	1	0	0	1	12	14	26
3 yrs	2	4	2	4	3	2	3	2	1	1	3	0	14	13	27
3½ yrs.	2	3	4	4	3	1	3	1	1	1	0	1	13	11	24
4 yrs	4	4	4	3	2	3	1	4	1	2	1	1	13	17	30
4½ yrs	3	3	4	3	2	3	2	2	2	2	2	2	15	15	30
5 yrs.	4	7	5	6	3	1	2	2	3	3	2	4	19	23	42
5½ yrs	5	4	4	3	2	3	3	2	5	3	5	3	24	18	42
											Totals		136	141	277

2. *The Tests* Only the test levels II to V-6 inclusive have been considered, since the range of testing except for the children above 5 years seldom went beyond The individual tests throughout were at that time roughly located at the test level at which 50% of the children of that age passed them All of the tests and the alternates at each six months' level are considered for both forms, making 111 tests in all Since the method of calculating Mental Ages had not yet been determined, a rough score was obtained for each child on each form by arbitrarily assigning a weighting of one point to each item of each test which the child passed, or was assumed to have passed because it was below the level at which he achieved all successes The total possible score was 168 points for each form The standards for scoring were the provisional ones in use at the time of

giving the tests In tabulating success and failure on individual tests over the age range, assumed successes and failures were taken account of separately from actual successes and failures, in order to have a basis for determining the relationship of number of negativistic responses occurring to the number of times the test was actually given, as well as the percentage of actual failures.

Since the amount of verbalization required by a test has a direct relationship to a child's consciousness of self, and this in turn has been accepted as one of the strongest factors in inducing negativistic reactions in a test situation, the tests have been classified according to the kind of response required of the child and the kind of stimulus giving rise to it, thus obtaining broader comparisons than can be shown between individual tests. The tests lend themselves readily to such a classification There are tests requiring a verbal response, tests requiring only some wordless activity on the part of the child, but in response to verbal directions on the examiner's part, and tests which could be administered and executed without a spoken word. Of the tests to which the child must respond verbally, there are those where the stimulus also is purely verbal, as in comprehension tests, giving definitions, materials, etc., where the child answers a question; those in which the stimulus is likewise verbal, but the response is prescribed exactly rather than demanding spontaneous selection, as in all repetition tests, those in which the verbal response is related to pictorial material, as in picture enumeration and description tests, pictorial absurdities, etc.; and those tests in which the response follows the presentation of some sort of object material, as in Naming Objects, Naming Objects from Memory, etc. Where a child must give some sort of performance after comprehending verbal directions, the stimulus may be pictures, as in Picture Memories, Patience: Pictures, etc.; objects, as Obeying Simple Commands, Identifying Objects by Name, etc.; or objects used incidentally to reveal the development of number concepts. Tests requiring no speech on the part of the child, and which could be understood without comprehending the verbal directions, may be drawing tests, such as copying figures, completion, etc, or tests of the form board and paper folding type.

3. *Classification of Negativism.* The definition of what behavior manifestations are to be understood as negativism in a given situa-

tion necessarily varies with the problem. Levy and Tulchin (6) broadly allowed "any behavior that interfered with intelligence testing." Rust (11) defined it in the nature of her experimental procedure, "Resistance is here defined as any form of behavior other than attempting a test within 30 seconds after it has been presented," but by this method she cannot invariably differentiate between bona fide resistance and failure which appears as silence in a slow subject Reynolds (10) says, "It is in this sense that the term 'negativism' is used throughout this study: namely, as a refusal to co-operate, manifested in any way and for any reason whatever." In the present study, of course, the examiner's aim when giving the test was neither to arouse negativism, nor to note it when it appeared, but to prevent or overcome it if possible, in order to secure in every case the child's best effort. If different methods, limited, of course, by the procedure, were unsuccessful in gaining the child's favorable interest for the task, the test where permissible may have been presented subsequently. Consequently, the number of times a test was presented varies, and the examiner's response to the child's negativism also varies with the child and the test

Negativism for our purposes may perhaps best be defined as *not attempting a test or part of a test.* The test was considered "not attempted" either when there was definite refusal, or when lack of response was fairly certain, as judged by other criteria, not to be due to simple failure. This could be checked by behavior manifestations at the time, comparison with response on comparable material in the other form, performance on later presentation of the same material, knowledge of the child's ability on similar tests, home comments subsequently made by the child, etc. In addition, only the instances of "I can't" and "I don't know" which were clearly indicated to be false were counted as negativistic reactions.[2]

Degrees of negativism have been variously classified. Levy and Tulchin (6) divided their children into those who refused all tests, refused one or more tests, did all the tests but required unusual coaxing, and did all the tests. None of the children in the present study would fall into the first group, and the division in the other groups would probably depend upon the interpretation of what was

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[2] N.-R is henceforth used as the designation of negativistic reaction

"unusual" in urging. Nelson (9) uses a four-fold classification based on the type of response. verbal resistance, physical resistance, "I can't" and "I don't know" when the situation was unambiguous and the child actually knew, and passive resistance or ignoring of the material presented or question asked The latter case may, of course, include failures. Reynolds (10) believes it is inadvisable to arrange types of reactions on a scale of seriousness because there is no satisfactory criterion for determining whether one type is worse than another. However, she analyzes her situations in terms of passive inattention and resistance, active inattention and resistance, and verbal protest

The present data lend themselves most effectively to an analysis in terms of two large general classifications each for type and degree of negativism Accordingly, it is possible to divide active from passive manifestations, resistance which may be overcome whether the result is success or failure from an attitude which is unyielding. We have these four descriptions, one of which fits each instance encountered. active objection to the test, which was never overcome, passive objection to the test, which under test conditions could not be overcome; active objection which yielded to urging; passive objection which yielded to urging[3] Active objection comprises those cases in which the child actually did something to avoid attempting the test. He may have gotten up, determinedly leaving the test situation, or pushed the test material away, or reached for something else which he insisted upon doing. He may have said, "I won't tell you," "I don't want to talk," "no, no!!", or just shaken his head in negation. Of this type also are the "I can't"s which have been later demonstrated to mean "I don't want to" A fallacy in this classification which cannot be overcome is accepting all "I can't"s and "I don't know"s not actually proven false as what they purport to be. More objective means for differentiating them would probably show the instances of negativism to be more numerous. This is likewise the case with passive resistance, where the error also is all in the direction of too few instances reported. If the response has been called passive objection, it designates the child's failure to comply rather than an assertion on his part. His attitude may be consistently intangibly antagonistic while he responds in no way whatever. He may, on the other hand, have been chattering freely, and on being presented with a task not of his liking, become immovably mute. He may sit passive and just not touch the blocks in spite of repeated proffering, but without voicing unwillingness. He may fail to give any response in the face of many opportunities when he is known to be able to attempt the task, or is accustomed to signify his inability Rust found silence to be the most frequent type of refusal In no case when a child made any sort of response to the test, however poorly or unwillingly performed, was it counted as an instance of negativism. If the child refused any item of a test, a negativistic reaction was recorded for the test

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[3] For brevity these classifications will be designated n r ac (no response obtained, active objection), n r pas (no response obtained, passive objection), d.r ac (difficult to obtain response, active objection), and d r. pas (difficult to obtain response, passive objection)

RESULTS

1 *Relation of Negativism to Age.* The results involving the 18-months-old group are not strictly comparable with the rest of the data because the number of tests for these children is so much smaller and therefore they have so many fewer opportunities to object. Also, the tests presented to these 18-months-old children were designed for older ones, and random interest in the material was considered an attempt Many of the 18-months-old children were not yet talking, and so no N -R. could be taken account of in the case of verbal tests. However, the data pertaining to this group are included in the study for what they may be worth

There are very few children of the younger ages especially who do not at some time during the test situation register some sort of objection. Of the 277 children, only 102, or 36 8%, failed to have a single instance of negativism recorded for them on either Form L or Form M. Table 2 shows the number and percentage of children

TABLE 2

NUMBER AND PERCENTAGE OF CHILDREN AT EACH AGE GIVING AT LEAST ONE N -R OF ANY TYPE ON EITHER FORM

Age	N cases Neg	%	Age	N cases Neg	%
1½	7	22 6			
2	22	88	4	23	76.7
2½	20	76 9	4½	23	76 7
3	23	85	5	23	54 8
3½	15	62 5	5½	19	45 2

at each age exhibiting any negativism, even if only a single instance. It is apparent that after the age of 4½ years there is a decided drop, showing many more children to be wholly cooperative. It is interesting to compare Rust's figure for initial resistance of her 3-year-old children with the percentage of these 3-year-olds showing any resistance. Rust found 84%, in close agreement with the 85% noted in this study. The numbers in each age group in the present study are unfortunately so small as to allow of chance variations, and this seems to operate especially in the case of the 3½-year-old group of children, a less negativistic group than may have been expected, as will be seen throughout the study.

A better measure for comparison between age groups is the amount and kind of negativism appearing at the various age levels, which is shown in Table 3. Since the number of tests given any one child varies, it is not possible here to relate number of opportunities with actual number of N-R.'s for the individual child.

TABLE 3

NUMBER OF N-R.'S OF ALL TYPES FOR THE CHILDREN AT SUCCESSIVE AGES (THE TWO FORMS COMBINED)

	Age								
Number N-R.'s	1½	2	2½	3	3½	4	4½	5	5½
0-1	28	7	10	7	13	15	10	32	32
2-3	2	7	4	4	4	7	13	4	6
4-5	1	5	3	6		1	4	2	3
6-7		4	4	2	2	2		2	1
8-9		1	3		2	1	1		
10-11		1	1	2	1				
12-13				3	2			1	
14-15			1						
16-17								1	
18-19							1		
20 or more				3		4	1		
N	31	25	26	27	24	30	30	42	42
Total N N-R.'s	12	87	104	195	78	187	116	73	41
Av. per child	.4	3.5	4.0	7.2	3.3	6.2	3.9	1.7	.98

It may be seen that although 2- and 2½-year-old children are very likely to react negatively at least once, they react negatively less often than do children of 3 and 4 years. There is a decided peak at three years, where occurs the greatest total amount of negativism as well as the largest average per child. There are also more children at this age having more than one N.-R. A peak almost as great occurs at 4 years, but here there are only half the number of persistently negativistic children, i e , only half the number of children exhibiting 10 or more N.-R.'s Aside from these two peaks, the average amount of negativism remains fairly constant from 2 to 4½ years, but shows a decided decrease thereafter

Table 4 gives the distribution of each type of negativism over the age range.

TABLE 4

NUMBER AND PERCENTAGE OF N -R'S OF EACH TYPE AT EACH AGE FOR BOTH FORMS COMBINED

Age	Total N tests given				N -R's					% Neg
		n r ac N	%	n.r pas N	%	d r ac N	%	d.r pas. N	%	over-come
1½	718	7	46 7	2	13 3	2	13 3	4	26.7	40
2	934	33	31 4	47	44.8	11	10 5	14	13 3	23.8
2½	1458	36	33 0	49	45 0	11	10 1	13	11 9	23 9
3	2097	85	44 0	39	20 2	50	25 9	19	9 8	35 8
3½	2206	19	27.9	10	14 7	17	25 0	22	32.4	57.4
4	2782	49	26 1	59	31 4	23	12 2	57	30 3	42 6
4½	2733	48	42 9	8	7 1	31	27 7	25	22 3	50
5	3616	11	15 1	8	11 0	14	19 2	40	54.8	74
5½	3303	0	0	5	11 9	9	21 4	28	66 7	88
Tot	19847	288	31 8	227	25 1	168	18 6	222	24 5	43 2

It will be seen from Table 4 that taking the group as a whole there is a fairly even distribution among the types of negativism. Active objection which could not be overcome was nearly 7% more frequent than the next most common type, passive objection which was not overcome. Practically the same amount of passive objection was overcome as was unyielding, but active objection on the whole was less frequently surmounted

The same relationship does not hold throughout the age range If any general tendency may be observed, it is that under 3 years most of the negativism is passive and, of whatever type, not likely to be overcome At 3 years, where negativism has become more frequent, it becomes more frequently active and a little more easily handled By 4 it becomes more passive. There is a strong flare-up of active resistance at 4½ years, but after that whatever negativism there is is largely passive in nature and may be overcome by urging. The frequency may be fairly constant between 2 and 4½ years, but there is a difference qualitatively through these ages.

There is a gradual but fairly consistent rise in the proportion of negativism which can be overcome. Perhaps with a larger number of cases the curve might be smoother With these groups, from less than a quarter of the instances yielding at 2 years, there is an advance to 88% at 5½, with the 50% point reached probably at 3½ years. If this finding is borne out by further experimental work, it should be of practical importance for the mental tester in estimating allowances for refused tests, as well as for everyone dealing with young children, in knowing what to expect as to the normal "outgrowing" of this tendency, how much resistance can be expected to be overcome at succeeding ages, how much more effort it will be necessary to put forth at one age than another in "handling" children, etc

2 *Sex Differences* It will be remembered that the group is fairly evenly divided between the sexes with 136 boys and 141 girls. The numbers are approximately equal also within the age groups, although they are too small for conclusions at any one group.

72 1% of the boys and 54 6% of the girls responded negatively at least once. More boys than girls responded negatively at every age after 2. There seems also a tendency for the differences in percentage of negativism to become greater after 4½ years, i.e., while the percentage of negativistic boys decreases, the percentage of negativistic girls decreases still faster.

In Table 5 the ages have been grouped at year rather than six-month intervals in order to increase the size of the compared groups. It may be seen that the frequency of N.-R.'s after 2½ years is also

TABLE 5

MEAN NUMBER OF N.-R.'S OF ALL TYPES FOR BOYS AND GIRLS AT AGES GROUPED BY YEAR INTERVALS (THE TWO FORMS COMBINED)

Age	Number		Av. N N-R's		Difference between means	Critical ratio
	Boys	Girls	Boys	Girls		
2-2½	24	27	3.3	4 2	9	96
3-3½	27	24	5 5	5.3	.2	10
4-4½	28	32	7 8	2 7	5 1	2 13
5-5½	43	40	1 4	1.3	1	17
Totals	122	123	4 2	3 1		

in favor of the boys, who average for the whole group one N.-R. more each than the girls The greatest difference between the sexes appears at 4-4½ years, but even this difference is not great enough to be statistically significant. Of cases showing high frequency of N -R.'s, 10 were boys and 7 girls. On the whole, there seems to be somewhat greater docility among the girls after 2 years, although at no age is this tendency sufficiently marked to be statistically significant. Passive and active N.-R 's are about equally divided between the sexes.

3 *Relation of Negativism to Tests.*

a. The individual tests The amount of negativism any test elicits ranges from 31%—nearly a third of all the times this test was given—to none at all. There was not a single instance of negativism recorded for 12 tests, and these tests range in location from the II-year to the V-year test level. The tests most often eliciting N -R 's are located below the IV-6 level With an average for all tests of less than one-half of one per cent (.46) negativism, figures ten and twenty times this amount assume significance. It is to be noted also that there is a very close parallel on tests which appear both in Form L and Form M, differing only in the particular items

Table 6 lists the individual tests arousing the most and least negativism No direct comparisons can be made, of course, with tests which have been found in other studies to be most conducive to negativistic reactions, but it is suggestive to note that Rust (11) found Repeating Two Numbers, Three-year Repeating Sentences, Five-Year Repeating Sentences, and Comprehension to head the list of the Kuhlman-Binet tests evoking negativism at three years Repeating Word Groups topped all Merrill-Palmer tests Of all situations she originally tried out, Reynolds (10) found Imitation and Repetition of Digits had the largest number of refusals.

Contributing extraneous causes operated to some unknown extent in the case of several of the tests in this study. Both picture absurdity tests and the comprehension tests were subsequently shown to have been tentatively located too low, and were therefore given an unusual opportunity for refusals On the other hand, Identifying Four Coins, for example, with a percentage of failure almost iden-

TABLE 6

TESTS ELICITING HIGHEST AND LOWEST TOTAL PERCENTAGE OF NEGATIVISM FOR TOTAL GROUP

Test	% of Negativism	Test	% of Negativism
Comprehension II (M)	31 0	Identifying Four Coins (L)	0
Comprehension II (L)	30.4	Three Hole Form Board—Rotated (L)	0
Pictures (M)	22 7	Sorting Buttons (M)	0
Comprehension II-6 (L)	21 0	Memory for Lines (L)	0
Pictures (L)	20 4	Memory for Designs (M)	0
Comprehension II-6 (M)	19 9	Aesthetic Comparison (M)	0
Comprehension III (L)	17 3	Identifying Objects by Name (L)	0
Comprehension IV (M)	14 3	Patience: Blocks (M)	0
Definitions by Use (M)	12 7	Number (L)	0
Memory for Words III (L)	11 4	Number Concept of Three (M)	0
Memory for Digits II-6 (M)	11 4	Number Concept of Four (M)	0
Memory for Digits II-6 (L)	11 0	Number (M)	0
Memory for Sentences III (M)	10 7	Naming Objects (L)	.5
Picture Absurdity (M)	10.6	Naming Objects (M)	5
Memory for Digits III (M)	10 4	Block Building—Bridge (M)	5
Memory for Sentences III (L)	10 2	Discrim of Animal Pictures (M)	5
Picture Absurdity III (M)	10 0	Copying a Circle (L)	.5
		Copying a Cross (L)	5
		Tracing a Triangle (L)	.5
		Pictorial Likenesses and Difs (L)	5
		Aesthetic Comparison (L)	.5
		Pictorial Sims and Difs. (M)	5
		Obeying Simple Commands (M)	5
		Counting Four Objects (M)	5

tical with the II-year Comprehension, shows not a single instance of negativism A special circumstance probably affects the Picture tests somewhat. A general procedure was used for the pictures at all levels in order to secure uniformity, and this procedure was not always understood at the early preschool levels, giving rise to bewilderment in some cases, and consequently a probably spuriously high degree of negativism for the test

Tests heading the various test levels were in all cases well down toward the least resistance end, indicating that rapport with the child must have been established before the test began, and that there is evidently no resistance-inducing effect intrinsically in the "starter" position However, the first *verbal* test the child encountered is under a handicap, as is the first test of a disliked type, for example, the first repeating digits test. The influence of fatigue is

TABLE 7

PERCENTAGE OF NEGATIVISM (TOTAL NUMBER OF N-R.'S DIVIDED BY TOTAL NUMBER OF TESTS GIVEN) FOR EACH TEST CLASSIFICATION (FOR BOTH FORMS) AT EACH AGE

Test classification	N tests	Total N given	Age 1½	2	2½	3	3½	4	4½	5	5½	Total group
Verbal Response: Pictures	12	2362	3.0	18.0	12.9	16.3	5.5	12.4	7.5	6.3	2.9	8.7
Verbal Response: Objects	5	880	0	0	2.8	0	1.1	3.1	0	0	0	.7
Verbal Response: Verbal Stimulus	16	2788	0	34.8	21.9	27.0	8.8	19.5	9.2	6.1	4.7	12.5
Verbal Response: *Repetition*	15	2582	0	18.9	11.8	16.2	5.3	15.1	9.4	1.1	.5	8.3
Performance	17	3020	3.3	6.3	2.4	3.4	.3	.3	1.6	0	.2	1.6
Drawing	13	2265	0	2.7	2.2	3.9	.8	.6	2.1	.9	.2	1.3
Performance Response to Verbal Directions: Pictures	15	2860	4.0	6.7	4.1	2.2	1.2	1.0	.6	0	.6	1.5
Performance Response to Verbal Directions: Objects	11	1972	1.7	.7	1.7	2.4	1.4	.8	.8	.3	0	1.0
Performance Response to Verbal Directions: No. Concepts	7	1135	0	0	4.1	1.6	0	0	0	.4	0	.5
Totals			2.09	11.24	7.48	9.2	3.08	6.76	4.1	2.02	1.27	

also disastrous, but this unfortunately cannot be shown objectively without a measure of the point at which it commenced to operate.

b. Test classification Table 7 indicates the relationship of the test classifications to negativism at successive ages For the entire group it is obvious that verbal tests requiring verbal responses arouse by far the most negativism, inducing it in 12.5% of all tests of that character given Picture tests requiring verbal responses and repetition follow with a little over 8% of N.-R.'s each. In the tests requiring repetition, both procedure and response are wholly verbal, but these tests are like the tests requiring verbal responses to pictures in that the child need not associate quite so freely as for the other purely verbal tests, notably Comprehension. He is not solely dependent upon his own store of impressions, but has an external cue for what is expected of him There is further evidence in favor of this principle found by analysis of the kinds of repetition Memory for words and memory for sentences, being less limited and involving less controlled association, evoke more negativism than memory for digits. Many children feel more at home and content in a highly circumscribed, more familiar situation.

These three types of tests comprise about 39% of the preschool scale, and for the remaining 61% the proportion of negativism is negligible It is the tests which require a verbal *response* that show high negativism, except for those using objects. Evidently the form of stimulus is not significant, since performance responses to purely verbal stimuli show slight negativism Tasks involving objects, whether the expected response is in the nature of speech or action, are readily executed, as are those using objects to test number concepts Picture tests requiring verbal responses elicit negativism nearly six times as often as those calling for activity. Both drawing tests and performance tests cause slightly more negativism than object tests, probably because a few of the children objected to certain specific performance tests or to all of the drawing tests, and made no objection to any of the verbal tests Not all children who reacted negatively, of course, followed the usual pattern of negativism involving all or most of the purely verbal tests, the repetition tests, and verbal response to pictures The following are illustrative cases of test behavior:

Case 1 Warren, 3-year-old boy. Form L given on first session Warren displayed an eager interest in the toys shown him in getting acquainted, and was soon chatting with the examiner about them, but refused to allow his mother to leave the room. He responded well to the first few tests which required only manipulation, but as soon as he was asked to verbalize at the examiner's request, he dropped all objects, sat back in his chair, biting his lips together very tightly and remaining otherwise motionless On presentation of object or performance tests, he would lean forward eagerly and participate, but distinctly and determinedly refused verbal tests and paper and pencil tests In Form M, also, Warren reacted negativistically to all verbal response verbal stimulus, pictures, and repetition tests given him, as well as to one performance test, Motor Coordination Warren's mother accounted for his objection to the drawing tests and Motor Coordination on the basis that they involved objects that were familiar to him that he could use and enjoy any time, and which were therefore of relatively little interest in comparison with all the attractive things he had come to see

Case 2 Richard, boy, 4½, in kindergarten Form M given first. Examiner's note. "Always smiled and gave a sort of laugh when refusing to respond, but was none the less determined. Same in school, according to teacher Refused to do things, but always smilingly and pleasantly, but will not yield School doctor was unable to give him physical examination because he refuses to open his mouth or do anything asked" On Pictures he said, "no", and politely but conclusively turned the page. "I won't tell you" was his affable answer for Comprehension, Materials, Opposite Analogies "No, I don't want to" disposed of all repetitions He pushed away Buttoning, refused to attempt the Knot, didn't want to draw a triangle, but was prevailed upon to try Even with the privilege of delivering a note to the teacher offered as a bribe, he would not complete the bird "No," he said, "I'll make a pig" He didn't want to fold a square, but in marked contrast was his alacrity in responding to Paper Folding—Triangle' "I'm going to make one, too," and took the paper to start before the examiner could give it to him

The various classifications maintain approximately the same relationship at successive ages Verbal response to verbal stimulus causes most negativism at 2 years, but it also holds a lead over the other classifications except at 4 and 5 years. Evidently as the child becomes older, he is better adapted to conversational give and take, and purely verbal tests present no such terrors as they formerly did. This is borne out by this classification's decreasing percentage of negativism.

Table 8 shows the character of N.-R.'s elicited by the various types of tests.

TABLE 8

TYPES OF NEGATIVISM FOR EACH TEST CLASSIFICATION FOR THE TOTAL GROUP ON THE TWO FORMS COMBINED

Test classification	% of all tests given arousing active negativism	% of all tests given arousing passive negativism	Total % negativism	Proportion of active negativism	Proportion of active negativism overcome	Proportion of all negativism overcome
Verbal Response: Pictures	4.5	4.2	8.7	51.7%	45%	56.6%
Verbal Response: Objects	1	6	7	14.3	0	67
Verbal Response:						
Verbal Stimulus	4.3	8.1	12.45	34.5	38	46
Verbal Response: Repetition	5.1	3.2	8.3	61.4	17	20
Performance	1.3	3	1.6	81.3	52.5	56
Drawing	1.2	.1	1.3	92.3	65	65.5
Performance Response to Verbal Directions						
Pictures	1.0	.5	1.5	66.7	55	48
Objects	.5	.6	1.1	45.5	44	45
Number Concepts	2	3	5	40.0	100	40

It can be seen that the kind of test arousing the most negativism does not necessarily occasion the most active negativism. Only 34.5% of the N.-R.'s to verbal response to verbal stimulus tests are active. Of the verbal tests, repetition elicits the highest proportionate amount of active negativism with 61.4%, while about half of the negativism on verbal response to pictures is active. The refusals on repetition may be more often due to actual distaste, whereas those on verbal response to verbal stimulus and pictures may be partially due to a general feeling of uncertainty as to what is wanted. However, as Reynolds (10) has pointed out, we do not know that any expression of negativism has any greater intensity or significance than any other sort. The small amount of negativism present on performance and drawing tests is almost wholly active Performance response to pictures has two-thirds of its N-R's active in expression

Active negativism is slightly easier to overcome than passive. As seen before, 43 2% of all negativism was finally overcome; and 46.3% of active negativism was overcome The most unyielding negativism is that appearing in response to repetition tests, where only 20% of all negativism was overcome, and only 17% of active negativism In all verbal response tests, as well as in performance tests, active resistance was more determined than passive resistance, probably, in the case of the verbal response tests, because passive resistance more frequently arose from a feeling of insecurity concerning what was expected. A sympathetic examiner can more easily eradicate this kind of resistance than the type which arises from an attitude of expecting to succeed in doing just as one pleases in spite of the examiner.

More initial negativism was overcome for verbal response to pictures and objects, performance, and drawing tests than for the average of all tests Active resistance to verbal response· verbal stimulus is in small proportion, but is relatively determined, only 38% of it being overcome.

c. Test difficulty Rust (11) felt that there was a slight but consistent tendency for her 3-year-olds to refuse the more difficult tests. Nelson (9) found a disproportionately greater tendency for children to resist hard tests—that is, on an MA level above their own. For the present group, since no MA's could yet be calculated to determine the position of a test in relation to MA, the percentage failing a test over its entire individual range was taken as a measure of its difficulty for the whole group, regardless of age. Failure is interpreted, in the cases where the test appears at more than one level, as inability to pass it at the lowest level at which it appears.

Correlation of the percentage failing each of the 111 tests with the percentage of negativistic reaction yields a coefficient of 068 ± .064, indicating that there is no apparent relationship between the difficulty of the task for the child and his objection to it. This may also be observed from the fact that the ratios of negativism to failure for the individual tests are in general quite small. Many special examples may be selected. The test causing most negativism, Comprehension at II years in M, was failed by 65% of the children to whom it was given, but Copying a Triangle in the same form, while failed by 68%, was reacted to negativistically only .7% of the times it was given Pictures in M, failed 22.2% of the times given, aroused negativism 22.7% of the time, while Giving the Number of Fingers, in L, much more difficult for the group which took it, was failed 94% of the time, but evoked only 7% negativism Repeating Digits at II-6 in M was failed only 26% of the time, but brought forth 11.4% negativism; Repeating Words at IV, being failed more than twice as often, or 61% of the time, caused less than half as much negativism, or 5 3% Evidently here it is not the difficulty of the test as such that causes the negativism. Some influence seems to be exerted by such previously mentioned factors as a test's being the first of a difficult or unpleasant type, or coming near the end of an examination when fatigue is operating The age for which a test is difficult is, of course, very important, since a test difficult for a three-year-old is more likely to be accompanied by expressions of resistance than is a test difficult for a 5-year-old Similarly, the same test given to both children, and difficult for both, will naturally be more likely to arouse negativism in the 3-year-old

4. *Effect of Test Experience* In the few studies in which there has been opportunity for comparing first and second examinings a fairly close correspondence has been found. In the present study Form L was given first in 140 cases, Form M in 137. Form L contains 57 tests, Form M 54, in the levels studied The number of N.-R.'s is fairly similar for Form L and Form M at succeeding ages. Exclusive of the cases which at some time or other reacted negativistically on both forms, 43 children showed negativism on Form L only (irrespective of whether it was given first or second), and 48 children on Form M only, also indicating that the forms are pretty well balanced in accepted and resisted tests

In Table 2 was shown the high percentage of cases reacting negativistically at least once during the total examination, inclusive of both forms. In general, there is a relationship between sessions If a child reacts negativistically in one session, he is fairly likely to do so in both. There is also a high degree of correspondence in the quantity of negativism, that is, a child who is responsible for a large number of instances of negativism at one examining period is likely to keep up his record on the other Eighty-three of the children were negativistic on both forms, although they were responsible for a few more N -R 's on the first than on the second form given. Of the 91 children who, as shown above, were negativistic on one form only, 66 were negativistic on only the first form given and 25 on the second only. An obvious explanation is that however much the examiner has tried to do to put a child at his ease, the strangeness of the situation still has its effect upon him By the second session, what is expected of him is already anticipated, and he has become more confident and therefore less self-conscious Also, the examiner is better acquainted with his vagaries, and has developed techniques for handling his particular contrarinesses This is borne out by the shorter time usually taken for the administration of the second form. The many fewer cases who show no negativism until the second form may have unpleasant memories of the first experience, or they may have become *too* confident! Since the forms duplicate the type of material quite extensively, there is also occasional annoyance at having to do the "same old thing" again But these latter cases are infrequent, and there is a distinct difference in favor of negativism's appearing on the first rather than on the second testing occasion

In contrasting the first form given with the second form given for the number of cases showing any negativism as well as for the gross number of N.-R 's at any age, we find that for the whole group nearly half as many children again were negativistic on the first form as on the second, and there were only 68% as many exhibitions of negativism on the second form as on the first. Beginning at two years there are more cases negativistic on the first form at every age The number of N -R 's runs about the same for first and second forms until three years where there is a clear-cut difference in favor of more N.-R.'s on the first form, there being only 55% as many on the second form. This difference continues to hold, but in lesser degree, except at the five-year level.

5. *Relation of Negativism to Test Score* It has been difficult in previous studies to determine the interrelationship between negativism and the test measurement of ability. The observed tendency is a negative relationship between MA or IQ and negativism Rust (11) notes that 25 of the 96 children finally accepting every test of the Kuhlmann-Binet scale showed 15 to 35 points increase in score.

TABLE 9

CORRELATION OF TOTAL SCORE WITH NUMBER OF *N.-R.*'S FOR THE SUCCESSIVE AGE GROUPS

Age	Coefficient of *r*	Age	Coefficient of *r*
1½	—.099±.119		
2	+.206±.129	4	—.400±.103
2½	—.418±.109	4½	—.285±.113
3	—.377±.111	5	—.208±.059
3½	—.061±.137	5½	—.027±.104

Table 9 gives the correlations for each age group of the child's total score with his number of N.-R.'s.

It is evident that at the ages of most frequent negativism, at 3, 4, and 2½ years, are the largest negative correlations, showing a tendency for a low score to be associated with many demonstrations of negativism. It is impossible to know, of course, whether actual inability gives rise to a feeling of inadequacy which results in negativism, or whether the negativistic reactions impair the discriminative ability of the test and cause poor scores. Probably both factors are operative, but it would seem impracticable to separate them. We do know that in only 43.2% of the cases when negativism occurred was an attempt secured for the test, and that these attempts resulted in success as well as failure. We have already found no relationship existing between individual test difficulty and negativism. The only case where this order is reversed is at two years, where there is a positive correlation of .206. It may be, of course, that a developmental factor is functioning here. Two years is the age preceding the levels on which a child begins to be conscious of himself as an entity, and emerges from passive acceptance to an active trying out of his new-found powers. Thus, especially at two years, one would expect a child advanced in development to be more negativistic. This would be consistent with the results of other investigations. The correlations decrease at the upper ages where there are fewer N.-R.'s.

The possibility was considered that *both* bright and dull children might be more resistive than average children. Accordingly, at the most resistive age, 3 years, the distance regardless of sign from the mean score for that age was correlated with the number of N.-R.'s. The correlation of —.094±.129 shows no relationship.

SUMMARY

Negativism as evidenced in the test situation depends upon predisposing factors within the child and exciting factors in the test situation. The age of the child is an outstanding predisposing factor. Whereas only 63.2% of the total group reacted negatively at least once, as many as 88% at 2 years and 85% at 3 years gave at least one N.-R However 2- and 2½-year-old children react negatively less *often* than do 3- and 4-year-old children. At 3 years occurs the greatest total amount of negativism and the highest average per child, and at 4 years there is a peak nearly as great, but only half as many persistently negativistic children. Other than this, the average amount of negativism remains fairly constant from 2 to 4½ years, decidedly decreasing thereafter. The small number of cases at each age must be taken into account in order not to attach undue weight to chance fluctuations Under 3 years most of the negativism is passive, and of whatever type, not likely to be overcome. It bebecomes more active until 4½ years, after which it is largely passive and amenable to influence. There is a gradual but fairly consistent rise in the proportion of negativism which can be overcome, from less than a quarter at 2 years to 88% at 5½. There seems to be a slight but statistically insignificant tendency for boys, on the whole, to be more negativistic, and the girls more docile, although the balance is a little in favor of more negativism from the girls under 2½ years.

The amount of negativism any test elicits ranges from 31% to none at all. Tests involving a verbal response to a purely verbal stimulus arouse by a considerable margin the most negativism, being followed by tests requiring a verbal response to pictures, and tests requiring repetition, which are about equal. Tests involving objects are readily accepted. And where performance responses to purely verbal stimuli are required, negativism is negligible, leading to the conclusion that the extent of the demand upon a child's spontaneous and not delimited association is an important factor in producing negativism. Although the various classifications maintain approximately the same relationship at successive ages, the lead held over other classifications in percentage of negativism aroused by verbal response to verbal stimulus decreases, probably because of an increasing adjustment with age to verbal communication.

The kind of test arousing the most negativism does not necessarily occasion the most active negativism. Of the verbal tests repetition tests call forth the highest proportionate amount of active resistance and yield least to influence. This may, because of the qualitative difference in expression, represent a different source for negativistic behavior: a specific distaste, rather than a general feeling of uncertainty as to what is wanted.

Active negativism is slightly easier to overcome than passive Whereas 43 2% of all negativism was overcome, 46 3% of active negativism was overcome. However, in verbal response tests and purely performance tests active resistance was more determined than passive resistance There is no apparent relationship between the difficulty of the test (without regard to the age range which took it) and negativism toward it. More important seem to be the related factors of the position of a difficult, unpleasant, or highly verbal test in the examination, and the age range to which a test is applied. In general, there is correspondence in the appearance and quantity of negativism during the two sessions, but there is a distinct difference in favor of negativism's appearing on the first rather than on the second testing occasion.

For the group as a whole there is no consistent tendency for absence of negativism to be associated with a high score, but at the ages where negativism is more frequent there is a slight tendency for negativism to be correlated with a low score In general the mean score of the less resistive group is decidedly larger than the mean score of the more resistive group, but it is not possible here to determine which variable primarily influences the other There is no reason to think on the basis of the present data that both bright and dull children are more negativistic than the average

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LES RÉACTIONS NÉGATIVISTES DES ENFANTS D'ÂGE PRÉSCOLAIRE SUR LA NOUVELLE RÉVISION DU TEST STANFORD-BINET

(Résumé)

Dans l'étude de 277 cas préscolaires employés dans la standardisation de la prochaine Nouvelle Revision du Test Stanford-Binet, on a constaté que l'âge est un important facteur prédisposant pour le négativisme dans le situation du test. Le négativisme se montre assez constamment entre 2 ans et 4½ ans, décidément moins après, le plus fréquemment à 3 ans, le plus activement entre 3 ans et 4½ ans La proportion qu'on peut surmonter devient constamment plus grande Nulle différence signifiante se montre entre les sexes

La quantité de négativisme causée par un test varie de 31% à nulle La plupart du négativisme est causée par les tests qui exigent une réponse verbale à des stimuli purement verbaux, puis une réponse verbale aux tableaux, et la répétition Les tests où il s'agit des objets ou des réponses d'exécution sont facilement acceptés, ce qui fait venir la conclusion que l'étendue de la demande de l'association spontanée et non délimitée est un facteur important Nulle relation ne se montre entre la difficulté du test et le négativisme On doit considérer plus importantes la position d'un test difficile, désagréable, ou très verbal dans l'examen et la variation des âges auxquels on soumet le test Il est plus probable que le négativisme se montre sur le premier

plutôt que sur le second examen Le résultat moyen est plus grand pour le groupe moins résistant que pour le groupe plus résistant, mais on ne peut déterminer quel variable influe en premier lieu sur l'autre

MAYER

NEGATIVISTISCHE REAKTIONEN BEI VORSCHULPFLICHTIGEN KINDERN MIT DER NEUEN REVISION DES STANFORD-BINET

(Referat)

Bei einer Betrachtung von 277 vorschulpflichtigen Fallen, die zur Standisierung der neuen Revision des Stanford-Binet gebraucht wurden, stellte es sich heraus, dass das Alter ein hervorragender, vorbereitender Faktor fur Negativismus in der Testsituation ist Der Negativismus zeigt sich ziemlich bestandig von 2 bis 4½ Jahren, bedeutend weniger danach, am haufigsten zu 3 Jahren, am wirksamsten zwischen 3 und 4½. Die Leichtigkeit der Überwindung nimmt gleichmassig zu Keine bedeutsamen Unterschiede zwischen den Geschlechtern zeigten sich

Der Umfang des Negativismus, der bei einem Test herausgebracht werden kann, rangiert von 31% bis auf Null. Der meiste Negativismus wird durch Tests aufgelost, die mundliche Antworten auf rein Verbalreize erfordern, dann Verbalantworten auf Bilder, und Wiederholung Tests, die Objekte oder Leistungsantworten verlangen, werden leicht angenommen, was zum Schluss fuhrt, dass der Grad der Forderung der freiwilligen und nicht der begrenzten Assoziation ein wichtiger Faktor sei. Kein Verhaltnis erscheint zwischen der Schwierigkeit des Tests und dem Negativismus. Wichtiger ist die Stellung eines schwierigen, unangenehmen, oder hochst mundlichen Tests in der Testreihe und die Altersrangierung, auf die der Test angewandt wird. Der Negativismus erscheint wahrscheinlicher bei der ersten als bei der zweiten Prufung Das Durchschnittsergebnis ist grösser fur die Gruppe mit weniger Widerstand als fur die Gruppe mit mehr Widerstand, aber wir konnen nicht feststellen, welche Variablen die anderen beeinflussen

MAYER

A STUDY OF THE EFFECT OF VARYING THE PROCEDURE IN THE BALL AND FIELD TEST*

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The Ball and Field has been one of the most difficult tests of the Stanford-Binet Scale to score. This difficulty is due partially, at least, to varying conceptions of what abilities are involved These included not only forethought and planfulness, but also comprehension

A review of the literature discloses very few discussions of this test. Meumann included it in his classification of tests of milieu. Terman (3) describes it as "a test of practical judgment . . . gives the subject a chance to show how well he can meet the demands of a real, rather than an imagined situation." Riley (1) found the Ball and Field test to have a biserial r of 31 with the Minnesota Assembly, and included it in a scale of ten Stanford-Binet tests indicating mechanical ability. He felt that these performance tests require, in common with tests of mechanical ability, speed of activity, motor coordination, manipulative skill, and a certain ability "to see relationships of a concrete nature" Various clinical psychologists, experienced with the test, have come to believe that the Ball and Field situation is more or less of an abstraction, and that a child faced with the actual necessity of finding a ball might or might not react as he does to this paper and pencil test Wells, for example, from the results of his Hole-in-the-Board test,[1] which presents a concrete situation involving an immediate search, believes that with this more concrete form of procedure the level of response is lowered.[2]

That the difficulty of scoring this test was early recognized is evidenced by the fact that in a study of errors in scoring the tests used in standardizing the Stanford-Binet, Terman (2) found the

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*Accepted for publication by Lewis M. Terman of the Editorial Board and received in the Editorial Office, October 30, 1934

[1] To be reported in a forthcoming study with Martha Taylor

[2] Expressed in a letter to the authors.

greatest number to occur on the Ball and Field Consistent classification of responses became an outstanding problem to the writers while scoring successively approximately 4000 performances obtained for the standardization of the new Revision of the Stanford-Binet. In addition to the large number of responses seen within a relatively short space of time, two other factors were present which should tend to make the difficulty more apparent than it would be in clinical practice. In the first place the scale was not scored as a whole. One age group at a time was followed throughout the whole range to which it had been administered, thus bringing out more sharply the contrasts between successive responses and the scores given them. In addition, this test was given to a wider range than that to which it has ordinarily been applied, since the age of the subjects ranged from about five to eighteen years.

An analysis of the remarks of the subjects and observations made by the examiners at the time of the test aroused considerable doubt as to how much comprehension necessarily lay behind a symmetrical plan. It also seemed possible that a sketchily made search such as Type O, Inferior, described below, might be as planful as a carefully worked out spiral type. The particular decisions causing the most trouble were in the case of detailed filling in of the field, sometimes with a single continuous line with few or no crossings or many crossings, and again with broken lines So numerous and varied in appearance were the responses of this sort that the line of demarcation between Failure and Inferior was particularly difficult to determine, especially since the writers felt that here was often simply a case of filling in a specified area without any comprehension of the task. It was suspected that the personality of the subject determined to what extent this filling in was compact, orderly, symmetrical, and, in fact, whether the whole response was sketchy or detailed

This test is known as the Plan of Search in the New Revision, and differs from the Ball and Field of the former Stanford-Binet in particulars of procedure, as well as in the type of field in one of the two forms. In Form L the same round field was used, and in Form M there is a diamond-shaped field The procedure in both forms is as follows. "Let's suppose that your purse with a lot of money in it has been lost in this big field. Take this pencil and start at the gate—here—and draw where you would go to hunt for the purse so as to be sure not to miss it" If the child stops, having made one line which goes no further than once around the field, the examiner is permitted one follow-up question, "But suppose you hadn't found it yet; show me *everywhere* you would go to look for it." In the present study only the diamond-shaped field of Form M was used Since but one follow-up question is allowed, it seemed feasible for giving as a group test for the more rapid collection of data

Two representative schools of neighboring communities with socially and economically average populations of children were chosen Part of the children in both schools were from a rural environment as it exists in central California There were a few more children of foreign-born parentage and a few more Japanese children in School B, especially in the lower grades In neither school had the children been given individual intelligence tests so they had not had previous experience with any form of the Ball and Field.

Three procedures were employed, all of which were equally applicable at the various ages and grades sampled. Each child in the classroom selected was given an 8½ x 11" sheet of paper in the center of which was mimeographed the diamond-shaped field of Form M, very slightly larger in size than that of the record booklet For the first procedure the examiner said, "See this (pointing to upheld diamond). Take your pencil and make any lines you want to inside it. . . Just any lines." In procedure 2 the directions were, "Now see this (pointing to upheld diamond) It is a field. Here is the gate down here. Suppose you were going for a walk in this field. Take your pencil, start at the gate, and draw wherever you'd like to walk" Procedure 3 was identical with that used in both forms of the new Revision of the Stanford-Binet, which is given in detail above.

Grades 2, 5, and 7 were chosen in both schools as representative levels The method of experimentation differed in the two schools. In the smaller, School A, all children of a grade were in one room. In this school procedures 1, 2, and 3 were given in succession, care being taken to collect each response to a procedure immediately on completion and before sheets for the next were distributed.[3] In School B, which was a considerably larger school, it was desired to compare the effects of procedure 2 and procedure 3 where neither had been influenced by a preceding experience with the test. Procedure 1 was not used in this school since there was already a record of it from School A, and being the first procedure it was not, of course, affected by any other procedure. Procedure 2 was given to one section of each of the three grades previously decided upon and procedure 3 to the other section. In the second grade these sections were the low and high divisions of the grade, but in the fifth and seventh grades the tests were given to two sections of the high fifth and high seventh. These sections had been formed because of convenience, and were not divided on the basis of ability The experiment was conducted during the last week of the school year at both schools. Table 1 gives the Median CA for each grade used.

TABLE 1

NUMBER AND MEDIAN CHRONOLOGICAL AGE FOR EACH OF THE GRADES USED IN SCHOOLS A AND B
(End of school year)

				Chronological Age		
	Grade	N	Procedure	Range		Median
School A	2	32	1,2,3	7-1 to	10-8	7-11
	5	27	1,2,3	9-5	12-9	11-1
	7	30	1,2,3	11-7	14-10	12-11
Total School A		89				
School B	H2	41	2	7-6	10-11	8-5
	L2	32	3	7-0	11-10	7-7 5
	H5	38	2	10-7	14-11	11-10 5
	H5	40	3	9-4	13-10	10-10.5
	H7	23	2	12-4	15-5	13-1
	H7	31	3	11-6	14-10	13-1
Total School B		205				
Total N			294			

Each of the writers scored all of the 472 responses independently and without regard for which procedure produced it, i e. as though each was a true Plan of Search test. The standards for scoring were those provisionally used at this time in the new Revision. In these 472 scores there were only 11 conflicts, and since in all of these cases each of the writers had questioned her scoring there was no difficulty in arriving at a decision. From the standpoint of reliability of scoring it is interesting to note that for these two scorers the coefficient of contingency corrected for broad grouping is .98

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[3] The possibility of copying was in this way guarded against as much as possible The test allowed of so little time and was supervised so carefully that we can safely assume the effect of copying to be negligible

COMPARATIVE RESULTS FOR THE PROCEDURES

Table 2 shows the scores obtained at each grade for the three procedures as given in School A.

TABLE 2

DISTRIBUTION OF SCORES BY GRADE FOR EACH PROCEDURE FOR SCHOOL A
(Each child given successively all three procedures)

Grade	N	Procedure	Failure N	Failure %	Inferior N	Inferior %	Superior N	Superior %	Inferior or better N	Inferior or better %
2	32	1	15	46.9	17	53.1	0	0	17	53.1
		2	16	50	16	50	0	0	16	50
		3	12	37.5	18	56.3	2	6.2	20	62.5
5	27	1	9	33.3	17	63.0	1	3.7	18	66.7
		2	3	11.1	23	85.2	1	3.7	24	88.9
		3	8	29.6	11	40.8	8	29.6	19	70.4
7	30	1	13	43.3	16	53.3	1	3.3	17	56.7
		2	5	16.7	25	83.3	0	0	25	83.3
		3	3	10.0	11	36.7	16	53.3	27	90

For second-grade children there is only slightly more success obtained from Procedure 3, although these children, of course, have had the advantage of experience with Procedures 1 and 2, which because of progressive differentiation of the task would be expected to foster comprehension. These children are exactly at the age at which an Inferior plan for the Ball and Field is required on the present Stanford-Binet. Actually there is less than 10% more of success with Procedure 3 than with Procedure 1, indicating that comprehension of the aim involved is not essential for success at this level.

At the fifth-grade level there is actually a greater percentage of inferior or better plans for Procedure 2 than for Procedure 3. It would seem also that at this age level of 11 years and 1 month, just below that at which a Superior plan is expected (12 years), comprehension is still not a necessary factor, for there are actually nearly three times as many complete failures for Procedure 3 as for Procedure 2. Procedure 3 calls forth a much greater number of Superior plans, showing that a child who gives a Superior plan has probably taken account of the whole situation, although it should be noted that it is possible for a Superior plan to be given without understanding of a search since Superior plans do occur with Procedures 1 and 2. As the child gets older Procedure 2 results in a greater amount of success than Procedure 1, probably because a younger child is less hampered by the need for explicit direction under such circumstances and is more accustomed to a free play situation.

As the child reaches the age at which a Superior plan is expected of him, a marked difference appears in the scores for the procedures. What has been scored as a Superior plan is evidently correctly interpreted as a planful search. At the seventh grade Procedures 1 and 2 still evoke a large number of Inferior plans.

Table 3 presents these findings in different form.

TABLE 3

COMPARATIVE SUCCESS BETWEEN PROCEDURES FOR SCHOOL A CASES AT THE GRADES SAMPLED

Grade	Procedure 1 equal to or better than procedure 3 N	%	Procedure 2 equal to or better than procedure 3 N	%	Procedure 1 equal to or better than procedure 2 N	%
2	20	62.5	23	71.9	25	78.1
5	17	64.9	18	66.6	18	66.7
7	9	30.0	13	43.4	18	60.0

TABLE 4

DISTRIBUTION OF SCORES BY GRADE FOR EACH PROCEDURE FOR SCHOOL B
(Comparable grade sections given one procedure only.)

Grade	N	Procedure	Failure N	%	Inferior N	%	Superior N	%	Inferior or better N	%
High 2	41	2	37	90.2	4	9.8	0	0	4	9.8
Low 2	32	3	20	62.5	11	34.4	1	3.1	12	37.5
High 5	38	2	17	44.7	21	55.3	0	0	21	55.3
High 5	40	3	11	27.5	18	45.0	11	27.5	29	72.5
High 7	23	2	7	30.4	16	69.6	0	0	16	69.6
High 7	31	3	5	16.1	15	48.4	11	35.5	26	83.9

It will be seen that the more complete the procedure the greater the advantage with increasing age.

In School B when Procedures 2 and 3 were given without previous experience with any other procedure there seems to be some advantage in the second grade for Procedure 3. Unfortunately the second grade here is inferior to the second grade in School A Whatever abilities are necessary for success in this situation, and which are common to Procedures 2 and 3, are lacking to greater extent in the second grade of School B, and therefore comparison cannot be made

In the fifth and seventh grades there seems to be no appreciable difference between the results from this method of using the procedures and those of School A. Again it is evident that only for the Superior plan does Procedure 3 have a real advantage.

TYPES OF PLANS

In order to interpret the responses to this test the three groups into which they had been arbitrarily divided in scoring were analyzed and classified into types, not according to any preconceived scheme of what might have been intended by the child, or by subjective opinion of excellence of response, but rather into groupings by similarities of design and the frequency of their occurrence It seemed best not to follow the classification of types given by Terman (3) inasmuch as his were characterized by subjective judgment of the intention, e g. Terman believed that "absence of plan is evidenced by the crossing and recrossing of paths or by 'breaks'." In the Inferior plan "that some forethought is exercised is evidenced (1) by fewer crossings (2) a tendency to make the lines more or less parallel or else to give them some kind of symmetry by fewer breaks." From the preceding results it is apparent that symmetry is not necessarily accompanied by forethought in the sense here used, and therefore perhaps the other factors taken as evidence of forethought or lack of forethought may also not actually be such.

The group scored as Failure resolved itself into eight types:

Type A Extraneous drawing, such as small figure, geometric design in center of field, e g, a rabbit or man or small-diamond with dot in center, or a group of emblems

Type B. Tracing around outline or drawing outside field

Type C. Only part of field covered, e g , a single incursion into field or outlining only one portion of field.

Type D. Random markings

Type E Involved, complicated filling in of field

Type F. A single line, regular or jagged, around the field, but confined too closely to the center to have been called Inferior.

Type G Irregular line weaving in and out with considerably less crossing than Type E but too much weaving to have been scored Inferior or to be Type M

Type H Partially unrelated lines and partially symmetrical design covering the field fairly well.

The Inferior group which is by far the largest, including every thing from a complete failure to the Superior plan, required nin classifications.

Type I Conventional cross, i e., one line straight through lengthwise and another line connecting the remaining two angles and bisecting the first line.

Type J Lines radiating from center or gate forming pattern such as fan, spokes, or a geometric design dividing the field

Type K Line once around field following outline with a cross inside, the lines of which connect the four angles.

Type L Line three-quarters of the way around the field then toward center and directly out, with fourth side omitted, or two lines following parallel sides with line connecting

Type M Line once around field with additional weavings or dippings in and out.

Type N. Line once around field so placed to take in whole field, either an exact diamond shape or with rounded corners

Type O Line twice around the field, or once around the field and incursion into center (not a cross), or a combination of these.

Type P. "Superior" method but halves or quarters of field treated separately

Type Q. Two plans which may be both Superior, e g , outer portion spiral and inner section cross lines as Type U, or one Superior and one Inferior, e g, spiral with a cross super-imposed, or a checkerboard effect.

Superior plans fall more readily into classifications:

Type R Spirals, holding to the diamond shape or circular

Type S. Concentric diamonds or circles.

Type T. Cradle. A line completely around the field which turns back on itself and goes around again, then turns back on itself and continues thus until it works into the center.

Type U Criss-cross Parallel lines weave back and forth, or zig-zags, covering the field These may be joined making a continuous line or may be separate lines. There may be a straight line through the center made at the beginning or end.

Type V Combinations of Type R and Type S, Type R and Type T

Division among so many types gives a relatively small number of cases for the less frequent types, making it impossible to draw any conclusions, but in some cases the distributions are suggestive. C, the most common type of Failure, is most frequent with Procedure 2 and rare with Procedure 1. Forty per cent of this type occur above the second grade. Evidently Procedure 2 gives the suggestion to explore the field, but lacking an objective this exploration is not complete or thorough. It should be noted, however, that 26% of this type was produced by Procedure 3, and it is the most frequent failure with this procedure

Strangely enough, in Type B which occurs most frequently with younger children we find the greatest number to be elicited by Procedure 3 which would seem to indicate the child has comprehended the task and is reacting to this procedure. On the other hand Types A and H are clearly unrelated to any knowledge of the task imposed. The fact that E and G occur chiefly with Procedure 3 implies a higher level of response than do the I and J Inferior types.

On analyzing the inferior types, we find that Types I and J, which are highly symmetrical, are produced almost entirely by Procedure 1, regardless of age level. Symmetry in this case is quite evidently not at all related to forethought, and therefore these responses probably could not be said to constitute a plan. On the other hand E and G discussed above are totally lacking in symmetry

Type L, resulting largely from older children, comes most frequently in response to Procedure 2. It is interesting to note that here as in Type C, also resulting largely from Procedure 2, the execution is economical, neglecting to outline the field completely, and perhaps here again the cause is the absence of an objective.

TABLE 5

DISTRIBUTION OF TYPES OF PLANS BY GRADE AND PROCEDURE

	Failure types								Inferior types									Superior types				
Grade	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V
2	10	14	60	0	5	4	3	1	13	8	0	5	11	18	14	0	0	4	0	0	0	0
5	4	1	28	0	6	3	8	5	7	11	4	8	20	18	21	0	1	15	4	1	1	0
7	4	2	12	2	0	2	0	4	4	6	4	13	7	19	13	5	8	18	1	2	3	3
Procedure																						
1	19	0	4	2	1	0	0	10	21	19	3	0	0	3	0	0	5	0	1	0	1	0
2	0	3	70	0	2	6	4	0	1	2	1	19	25	35	19	1	0	1	0	0	0	0
3	0	14	26	0	8	3	7	0	2	4	4	7	13	17	29	4	4	36	4	3	3	3

Likewise Type M, characterized by its irregularity of line, is predominantly from Procedure 2, but also present with Procedure 3, indicating that the suggestion for this type is inherent in the part of the two procedures which is common to both, i.e., drawing "where you would go" This type is most common at the age at which one would expect a good Inferior plan—just below the Superior-plan age level.

Type N, the most frequent Inferior type, is distributed equally over the grades sampled, and results twice as often from Procedure 2 as Procedure 3 and practically not at all from Procedure 1, showing that it is more likely to be associated with incomplete apperception of the content of the procedure

Type O, the second most common variety of Inferior plan, results strikingly more often from Procedure 3 than Procedure 2 and not at all from Procedure 1. *At this point another possibility* of this method of analysis becomes apparent. In this case, as in Type P, the fact that the bulk of responses appear in relation to Procedure 3 and from older children raises the question of whether these types do not more closely resemble the results with the various types of Superior plans and should perhaps be scored Superior. These two types, on the basis of these distributions, comprise the only doubtful decisions between Inferior and Superior whereas there seems to be no distinct line between the Failure and Inferior classifications. O differs, however, from all Superior types in that its frequency of appearance does not consistently increase with age.

All types now known as Superior are associated almost without exception with Procedure 3, indicating a complete comprehension of the task and a truly planful search. It must be borne in mind that nearly 50% as many so-called Inferior plans come from Procedure 1 as from Procedure 3, and it is possible to have even a Superior *plan resulting from Procedure 1.* In an individual case, therefore, even if a Superior plan is given one cannot be certain that the child has fully comprehended the task.

SUMMARY AND CONCLUSIONS

With the idea of discovering in which types of response to the "Ball and Field" test comprehension of the task may safely be assumed to be present, the procedure was varied in the following ways in Procedure 1 the child was told to make any lines he wanted to inside the diamond-shaped form he had been given; in Procedure 2 he was to draw wherever he would like to walk if he were going for a walk in the field; Procedure 3 was identical with that used in the new Revision of the Stanford-Binet. The experiment was administered as a group test. Two schools of socially and economically average population were chosen in which all the pupils of grades 2, 5, and 7 were used

The results were scored by the provisional standards for the new Revision of the Stanford-Binet as Failure, Inferior, and Superior regardless of the procedure used These three groups were classified into types of plan on the basis of similarity of design and frequency of occurrence. From this objective analysis we find that, exclusive of the Superior plans, the less specific the procedure the greater is the symmetry of design Furthermore, the sketchy, scant covering of the field by a method other than Superior is also associated chiefly with the less explicit procedures, and with younger children. In general, therefore, below the Superior level, a detailed, complicated plan is probably more indicative of *some* comprehension of the task than a straight-lined symmetrical design. At the Superior level, however, a sketchy plan is evidently as indicative of forethought as a more thorough covering of the field by the same method.

In comparing the various procedures it was found that Procedure 3 has a distinct advantage over Procedures 1 and 2 only in the case of Superior plans and for the oldest children. Procedures 1 and 2, which make no demands for forethought or planfulness, produce as many as 59 3% of responses of the sort scored Inferior or better. This should lead to grave doubts as to whether the present "Inferior" level in general gives real evidence of cognizance of the full import of the situation There is, however, some increase with age of the frequency of this level of response even with Procedure 1, which must be due to other factors than were thought to be involved. This study has not been extended to an investigation of these factors, which we may perhaps tentatively call "mental organization " Since we cannot differentiate the Failure and Inferior levels on the basis of whether or not comprehension of the task is present, we are probably not justified in scoring the test at these levels Only in the Superior types (and possibly O and P of the Inferior group which resemble the Superior in design as well as in the fact that they occur predominantly with Procedure 3 and with older children) is there sufficient evidence of planfulness to satisfy the traditional concepts of this test Therefore it is felt that the Ball and Field (or Plan of Search) test should be scored only for Success or Failure, the latter to include everything other than the Superior types and O and P of the Inferior group.

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UNE ÉTUDE DE L'EFFET DE VARIER LE PROCÉDÉ DANS LE TEST DE LA BALLE ET DU CHAMP

(Résumé)

Pour déterminer les types de réponse au test "de la Balle et du Champ" lesquels montrent une compréhension de la tâche, on a varié le procédé de la manière suivante dans le Procédé 1 on a dit à l'enfant de faire toutes les lignes qu'il voulait dans la forme d'un diamant qu'on lui avait donnée, dans le Procédé 2 il devait dessiner où il voudrait aller s'il était sur le point de se promener dans le champ, le Procédé 3 a été le même que celui employé dans la nouvelle Révision du Stanford-Binet. L'expérience a été administrée comme test collectif. On a choisi deux écoles d'une population socialement et économiquement moyenne où on a employé tous les élèves des années 2, 5, et 7

Les résultats ont été marqués selon les étalons provisionnels pour la nouvelle Révision du Stanford-Binet comme Non Réussis, Inférieurs, et Supérieur *sans égard du procédé employé Une analyse objective montre* qu'en général, au-dessous du niveau Supérieur un plan détaillé et compliqué indique probablement plus *quelque* compréhension de la tâche qu'un dessin symétrique à lignes droites Le Procédé 3 est distinctement plus avantageux que les Procédés 1 et 2 seulement dans le cas des plans Supérieurs et pour les enfants plus âgés Les Procédés 1 et 2, puisqu'ils n'exigent ni prévoyance ni capacité de faire un plan, produisent 59,3% réponses Inférieures Puisqu'on ne peut distinguer les niveaux Non Réussi et Inférieur sur la base de la présence de la compréhension de la tâche, on ne devrait probablement pas marquer les résultats du test à ce niveau, mais seulement comme Succès ou Insuccès.

ODEN ET MAYER

EINE UNTERSUCHUNG ÜBER DIE WIRKUNG DER VERÄNDERUNG DES VERFAHRENS IN DEM BALL- UND FELDTEST

(Referat)

Um zu bestimmen, welche Typen von Antwort auf den "Ball- und Feldtest" ein Verstandnis fur die Aufgabe zeigen, wurde das Verfahren in den folgenden Weisen verandert. im Verfahren 1 wurde dem Kind gesagt, irgend welche Linien innerhalb der ihm vorgelegten diamantformigen Form zu zeichnen, die es wollte, im Verfahren 2 sollte es zeichnen, wo es gehen mochte, wenn es einen Spaziergang auf dem Feld machen wollte; Verfahren 3 war identisch mit dem in der neuen Revision des Stanford-Binet gebrauchten Verfahrens. Die Untersuchung fand als ein Gruppenversuch statt Zwei Schulen der sozial und okonomisch durchschnittlichen Bevolkerung wurden gewahlt, in denen alle Schuler der Stufen (grades) 2, 5, und 7 gebraucht wurden

Die Ergebnisse wurden nach den provisorischen Massstaben für die neue Revision des Stanford-Binet verwertet, wie Versagen, Untergeordnetheit, und Überlegenheit, ganz von dem gebrauchten Verfahren abgesehen Eine objektiv Analyse offenbart, dass unter dem uberlegenden Niveau im allgemeinen ein ausfuhrlicher, verwickelter Plan wahrscheinlich andeutender fur einiges Verstandnis der Aufgabe ist als eine geradlinige symmetrische Zeichnung Verfahren 3 hat einen deutlichen Vorteil uber Verfahren 1 und 2 nur in dem Fall der uberlegenden Plane und fur die altesten Kinder Verfahren 1 und 2, welche keine Vorsicht oder Planmassigkeit verlangen, bringen 59,3% der untergeordneten Antworten heraus Da wir die Versagen- und Untergeordnetheitsschichten auf Basis davon unterscheiden, ob Verstandnis der Aufgabe vorhanden ist oder nicht, sollten wir den Test auf dieser Schicht verwerten, aber nur als Erfolg oder Versagen.

ODEN UND MAYER

INFLUENCE OF MUSCLE TRAINING ON BIRTH-INJURED MENTALLY DEFICIENT CHILDREN*

From The Training School at Vineland, New Jersey

S GERALDINE LONGWELL

I HISTORICAL SETTING

SIX years ago The Training School at Vineland, New Jersey[1] undertook treatment on a small group of children[2] with motor handicaps due to intracranial birth lesions. A research program of muscle training was begun under the direction of Dr Winthrop M Phelps, Professor of Orthopedic Surgery, Yale University School of Medicine, and Consultant on Birth Injuries to The Training School, and with the assistance of Mrs Carolyn M. Brown, Chief Physical Therapist, New Haven Hospital. As one phase of this project, the Vineland Laboratory was asked to measure such progress as might be made by these children during treatment, with special reference to mental improvement and general behavior. The present study is a preliminary report of progress made in the direction of spontaneous improvement in social functions coincidental with treatment. The study was initiated by and made under the general directon of Dr. Edgar A. Doll The author is also indebted to Dr. George Kreezer for suggestions for organizing the material of this report.

Numerous possibilities were anticipated from the muscle training in these subjects, and a brief account of the several lines of psychological inquiry may serve as a background for the setting of this report. The most immediate problem was the clarification of intracranial birth lesions as a category from the point of view of clinical psychology This problem was worked out on the basis of a survey of the institutional population which yielded data as to the

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*Recommended by Edgar A. Doll, accepted for publication by Carl Murchison of the Editorial Board, and received in the Editorial office, August 15, 1934

[1] A private institution for the care and training of mentally deficient patients

[2] The term "children" is used in this article without regard to life age for mentally deficient subjects.

clinical psychological aspects of birth lesions as well as the frequency of occurrence of different types. Other problems were encountered bearing on the relation of the site of lesion to mental or physical consequences, on the relation of birth lesions to difficulties of speech, personality, and learning. Still other inquiries were directed toward measuring such improvement in mental ability as might directly or indirectly follow from muscle training Mental growth studies were also considered (2, 3, 4, 5)

Obviously, the most direct benefits of muscle training were expected in neuromuscular coordination The immediate estimation of such improvement was a problem for the orthopedist with reference to muscle tonus, timing, coordination, and the effects on body mechanics (9, 10). The consequences of these effects in the general behavior of the individual were considered proper topics of psychological observation. Studies were therefore undertaken on the range and extent of movement from the point of view of the practical or social behavior of the subjects, as in gait and in the application of gross and fine coordination to everyday acts. Motion picture studies were made for developing a permanent progress record in terms of a definite routine of movements.

II. Problem

The present study was conceived as a means of measuring the genetic social development of the individual in terms of those performances commonly accepted as characteristic of successive age periods in the genetic evolution of the child from infancy to adult life. By social performance we mean here such abilities in early life, or at low mental levels, as ability to dress, to wash, to feed one's self, to get about, to look after one's own interests, to communicate with others and, in short, those items of self-help which are important in infancy and early childhood At later ages, or at higher mental levels, the emphasis shifts to largely social responsibilities of self-direction and more general social relationships. In the main we have been concerned with those social performances which depend largely for their success on motor facility. But we have included non-motor items insofar as these seem to be the product of experience gained through motor activity. We are not concerned here with neuromuscular coordination or improvement in body mechanics as such It will be evident that the study confines itself to the incidental or spontaneous capitalization of such improvement for social behavior

The subjects of the investigation were all mentally deficient children with motor handicaps resulting from intracranial birth lesions The orthopedic diagnoses and the judgment as to etiology were made by Dr. Phelps. The psychological diagnoses were made in the clinical department of the Vineland laboratory. In view of limited facilities for treatment, not all patients diagnosed as birth-injured received muscle training. Those patients were preferred who offered the most promise from the standpoint of age, mentality, and type of handicap. Generally speaking, young patients were preferred to older patients, and those with severe disabilities were preferred to those with milder handicaps The control group of subjects was similar to the treatment group except for these preferences.

Muscle training[8] *in this study involves a period of relaxation* for about 20 minutes, followed by a period of about 40 minutes of clinically prescribed movements. These movements are both assisted and unassisted, while in the more advanced stages movement is made against resistance or gravity The motions are made in an even, rhythmical manner, often to nursery rhymes for the younger children. For arm, neck, and some leg exercises, the patient lies on a plinth or raised table. Other arm, hand, and leg motions are performed in sitting positions and later standing or walking. Treatment in finer coordinations, such as wrist or finger movements, is carried on at a table. Mirrors and other apparatus are used in assisting the patient. All muscle training is done to prescription following orthopedic examination and is designed to accomplish specific neuromuscular improvement (5, 9). The particular schedules for measuring improvement used in this study are not part of the treatment, but represent incidental or spontaneous capitalization of the results of treatment

III. METHOD

In developing the method of the present study it was necessary to devise a schedule of performances which might be used for continuous progress Beyond such scales of genetic motor development as those of Gesell (7) and Shirley (11) and a job analysis of dressing by Buhl, (1), we found little in the literature suggestive of a schedule of performances which seemed useful to our purpose. The chief contribution of existing scales was in the category of locomotion. Our categories have therefore to some extent been selected from the literature, but to a much greater extent have been suggested by members of the laboratory staff and systematized by the author.

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[8] Muscle training was given an hour a day, 3 days a week (except for interruptions due to illness and vacations) by Mrs Alice M James The subjects received, on the average, 120 treatments a year

The items were obtained by listing the performances of a few birth-injured subjects and then adding to this list other performances expected of physically normal subjects of corresponding life ages and mental ages. The new list thus made was tried out on other birth-injured subjects, revised and tried again and again until we had what seemed to be a fairly satisfactory list of representative performances. The individual abilities in the list fell into a few well-defined categories The individual performances have, in some instances, been arranged in a tentative order of an ascending hierarchy based on apparent degree of difficulty. The categories themselves are arranged in no special order. This schedule of items is not a calibrated scale and does not pretend to be exhaustive.

The method involved the following steps (1) the construction of a list of motor abilities which it would be desirable for the child to possess in meeting the basic needs for social independence in everyday life, and (2) the comparison of progress made in the acquisition of these abilities by two groups of subjects: (*a*) a group receiving treatment by muscle training procedures, and (*b*) a group similarly constituted with respect to many of the factors which might determine the acquisition of such abilities, but not receiving muscle training.

Our study follows along the lines indicated by this plan, although it was not possible, in view of the material available, and certain practical considerations of treatment, to meet all the conditions that experimental rigor would demand. These limitations may best be considered after the data have been presented

Abilities to Be Examined. In Table 1 is given a list of the performances with respect to which the abilities of the subjects were examined. These performances are grouped logically under class names which indicate their use in satisfying certain of the requirements made of an individual living in a simple social group, such as, for example, the family. This classification is for convenience of analysis.

TABLE 1

PERFORMANCE SCHEDULE

Showing the list of performances with respect to which the subjects were examined.

- A Locomotion
  - 1 Chin up
  - 2 Chest up
  - 3 Sits with support
  - 4 Sits alone
  - 5 Creeps
  - 6. Stands with support
  - 7 Stands alone
  - 8 *Walks with support*
  - 9 Walks alone
  - 10. Goes up and down stairs with aid
  - 11 Goes up and down stairs using two feet to each tread
  - 12 Goes up and down stairs with alternate feet on alternate treads
  - 13 Runs
  - 14. Skips
- B. Dressing
  - 1 Cooperates with removal of clothes
  - 2 Removes coat if unbottoned
  - 3 Unbuttons and removes coat
  - 4 Removes shoes and stockings, if unfastened
  - 5. Unfastens and removes shoes and stockings
  - 6. Removes rest of clothing, if unfastened
  - 7. Unfastens and removes rest of clothing
  - 8 Cooperates with dressing
  - 9 Puts on coat—assisted
  - 10 Puts on coat—unassisted
  - 11 *Buttons coat*
  - 12 Puts clothes on—assisted
  - 13 Puts clothes on—unassisted
  - 14 Fastens clothes
  - 15. Puts shoes and stockings on—assisted
  - 16. Puts shoes and stockings on—unassisted
  - 17 Laces and ties shoe laces
  - 18. Brushes teeth
  - 19. Combs hair
- C Bathing
  - 1 Washes and dries hands
  - 2 Washes and dries face
  - 3. Washes and dries neck and ears
  - 4. Bathes self with supervision
  - 5 Bathes self without supervision
- D. Eating
  - 1 Carries to mouth successfully
  - 2 Holds and drinks from cup—unassisted
  - 3 Begins to use spoon—*spills*
  - 4 Uses spoon—no spills
  - 5 Uses fork
  - 6 Uses knife to spread
  - 7 Uses knife to cut

TABLE 1 (*continued*)

E. Communication
    1 Laughs, cries; vocalizes
    2. Begins to use words
    3. Uses words
    4. Uses phrases
    5 Uses sentences
    6. Gesticulates
    7 Scribbles
    8. Writes or prints from copy
    9 Writes composition—letter home
    10. Tells name
    11 Prints or writes first name
    12 Writes full name
F Control of excretory functions
    1 Bowel control partly established
    2 Bowel control established
    3. Daytime bladder control partly established
    4 Daytime bladder control established
    5. Night-time bladder control established

All of the performances listed except those in Group F involve the activity of the skeletal musculature They are: performances (1) which might be prevented from developing as a result of motor paralysis, and (2) which might be acquired as a result of muscle training, if this method of treatment is effective in improving the motor efficiency of a person suffering from muscular disorders. The list includes not only performances which are directly useful to an individual in meeting his needs, but also performances which may represent stages in the acquisition of an ability of direct practical use. For example, in the list of performances included under locomotion, the first eight items represent stages which precede the development in young children of the ability to walk and so may be used as a scale to estimate the extent to which a person incapable of walking has progressed toward the acquisition of this ability.

Group F includes performances which involve the control of smooth sphincter musculature regulating the excretory functions. This group is included in our list since it was considered possible that with the development of control over the skeletal musculature might go a corresponding control of the smooth muscles which in normal adults, and in children above a certain age, are under voluntary control.

Since none of the subjects was under 10 years of life age it was assumed that, except for the physical handicaps, all of these performances could logically be expected in children of this age in terms of genetic development Performances involving writing, bathing without supervision, and perhaps using a knife might not ordinarily be expected of mental ages below six years. However, it is possible that the last two items could reasonably be expected of these subjects because of their physical growth and development, since they are at least 10 years old. Similarly, on the basis of mental age all performances but those involving writing could reasonably be expected of each member of both groups.

The performance of the abilities listed was also influenced by training in the everyday cottage situation, particularly with respect to those young patients whose self-help in matters of dressing, bathing, and eating was not complete It will not be possible to say what gains were due to this training and what to the physical therapy alone.

Another uncontrolled variable is that of motivation On the whole, motivation was good The subjects enjoyed the extra attention derived through treatment. They were stimulated to be interested in acquiring various abilities In some cases a wholesome rivalry was encouraged.

The method of determining whether the subjects could perform the abilities listed involved both report and observation. The subjects were observed in their everyday environment and were asked to perform acts which were not observed to occur spontaneously The act of writing, for example, was not always observed as a spontaneous occurrence, but the presence or absence of the ability to write could be determined upon request Other abilities were more readily checked through reports from the cottage attendants. When there was doubt as to the performance, the subject was called in and a demonstration required. This was particularly advisable if there was any question as to the assistance given or the completeness with which the item was performed

The scoring of the individual performances was accomplished simply. The criterion of success adopted required that the act be an established response rather than one which could be performed only occasionally. If a subject was thought capable of performing certain acts of self-help but seldom did so, he was considered socially incapable with respect to those items.

Therefore, if the subject always succeeded in any given performance, he was marked plus If he always failed, he was marked minus. If he succeeded in the majority of trials, he was scored a marginal plus If he failed in the majority of trials, he was scored a marginal minus These latter two scores occurred but rarely. If the subject refused to perform, or if the examiner overlooked an item, it was marked zero.

IV. The Subjects

1. *The Treatment Group* The individuals included in the treatment group are: (*a*) those who have been receiving muscle training for at least two years, and (*b*) who have been scored on the performance list four times (semi-annually) while under treatment Four sets of scores were the maximum number available. The first criterion was set up so that as many of the treatment cases as possible would be included and yet only those who had been treated long enough to warrant some expectation of change. The second criterion was set up in order to exclude individuals who might have had the requisite period of training but who had been dropped from treatment during the course of the study for reasons outside our control. This group includes 9 boys and 1 girl

2. *The Non-treatment Group* The non-treatment group is taken from other residents of the institution who also represent a clinical diagnosis of dyskinesia associated with intracranial birth lesion. Ideally, the non-treatment subjects selected for this study should match the treatment group in life age, mental age, type of involvement, degree of handicap, and in other relevant characteristics, but we could only approximate this equivalence from the material available. Nine of the subjects were selected on the following bases: (*a*) they had received no physical therapy and (*b*) they had been scored on the performance schedule four times. In order to make the non-treatment group equal in numbers to the treatment group, a tenth subject was selected from among those who had had some treatment. This individual had had five months of treatment, which had been discontinued for lack of cooperation a year before this study began This individual also fulfilled the second requirement, and so far as we could judge from observation, from the report of the physical therapist and from the neurological reports and examinations, had shown no improvement during the period of treatment. The group included 7 boys and 3 girls.

3. *Comparison of the Two Groups.* A comparison of the two

TABLE 2

Description of Subjects

Case No.	M A (Binet)	L.A	I Q †	Type	Involvement	Lesion	Practical handicap	Therapy (years)
		A. Showing the characteristics of the 10 treatment cases with respect to various details						
1	4.2	10.8	39	Spastic	Paraplegia	Cortical pyramidal	Speech and gait	4.0
2	5-6*	17.8	40*	Athetoid	Quadriplegia	Basal nuclear	Speech, gait, and manipulation	4.5
3	5.7	11.6	49	Spastic	Quadriplegia	Cortical pyramidal	Speech, gait, and manipulation	2.0
4	6.2	13.4	46	Spastic	Paraplegia	Cortical pyramidal	Speech and gait	4.0
5	6.5	11.0	60	Athetoid	R Hemipilegia	Extra-pyramidal	Speech, gait, and manipulation	4.5
6	7.0	16.0	50	Athetoid	Quadriplegia	Extra-pyramidal	Speech, gait, and manipulation	2.0
7	8.0	28.6	57	Spastic	Quadriplegia	Cortical pyramidal	Speech, gait, and manipulation	4.0
8	11.3	19.3	58	Mixed	Quadriplegia	Cortical suggesting basal	Speech, gait, and manipulation	2.0
9	12.2	13.9	88	Athetoid	Quadriplegia	Extra-pyramidal	Speech, gait, and manipulation	4.5
10‡	13.0	20.2	93	Spastic	L.Hemiplegia	Cortical pyramidal	Speech, gait, and manipulation	3.0
				B. Showing the characteristics of the 10 non-treatment cases				
1	3-4*	10.0	35*	Spastic	Paraplegia	Probably cortical	No speech. Mildly defective gait	
2	4.0	15.0	28	Spastic	R.Hemiplegia	Pyramidal sympathetic	Speech, gait, and manipulation	
3	6-7*	11.2	60*	Spastic	Paraglegia	Suggestion of cortical irritation	No speech—deaf	
4§	7.0	16.4	50	Not stated	R.Hemiplegia	Diffuse basal corpus striatum	Mildly defective speech, gait, and manipulation	
5	7.3	33.4	52	Spastic	Paraplegia	Not stated	Gait	
6	9-10*	58.6	70*	Athetoid	General incoordination	Extra-pyramidal	Speech, gait, and manipulation	
7	9.3	17.4	66	Intention tremor	General incoordination	Extra-pyramidal	Speech, gait, and manipulation	
8	9.3	27.5	66	Spastic	Quadriplegia	Cortical pyramidal	Gait and manipulation	
9	11.8	46.4	84	Athetoid	General incoordination	Extra-pyramidal	Speech, gait, and manipulation	
10	12.6	44.3	90	Mixed	General incoordination	Extra-pyramidal, probably basal	Speech, gait, and manipulation	

*Estimated

†Calculated on 14-year basis for ages beyond 14

‡Jacksonian epilepsy suspected as complicating factor.

§Intra-cranial tumor; epiphysitis juvenalis, received therapy 5 months with no noticeable effect groups brings out both similarities and dissimilarities In the first place, both groups are composed of birth-injured, mentally retarded, physically handicapped subjects residing in an institution for feeble-minded children. Most of the group reside in a cottage set apart for crippled children, and age for age, receive about equal amounts of stimulation, encouragement, and training in the cottage situation The two groups are described and compared in Table 2.

As previously mentioned, the treatment group by selection tends to be younger. All but two of them are under twenty years of age In the non-treatment group, on the other hand, five subjects are more than twenty years old, three being beyond forty years of age. The mental ages, however, are more nearly alike for the two groups. Some mental ages are estimated because accurate Binet examinations could not be made in view of the motor and language difficulties present. As a matter of fact, these mental ages are considered fairly accurate even though based on subjective judgment, supplemented as they are by tests other than the Binet. The groups are fairly comparable as to site of lesion and type of disability, though the treatment group has a preponderance of quadriplegias while the non-treatment group has more cases of general incoordination. The six quadriplegias in the treatment group are more seriously affected as a group than the four cases of general incoordination in the non-treatment group as judged by abilities lacking in the two groups.

V. RESULTS: CHANGES IN ABILITIES FROM FIRST TO LAST RECORD

The subjects were scored in respect to their ability in each of the detailed performances four times, at six-months' intervals Table 3 records the gains possible and the gains actually made by the ten treatment cases from the first to the fourth records. Table 4 is identical for the non-treatment cases *P* indicates that the ability was already present when the study began. *G* indicates that some time between the first and fourth records the subject gained this ability. *L* indicates that the subject had this ability at the first record, but then lost it and had not regained it by the fourth record. *A* indicates that at the first record the subject did not have this ability nor did he gain it during the course of the study.

Table 5 is a comparison of Tables 3 and 4, presented with reference to the major categories The first row is to be read thus· With respect to the category of locomotion, the treatment group lacked 25 abilities among 9 subjects; 3 abilities were gained by 2 subjects;

TABLE 3

RECORD OF CHANGES FROM FIRST TO FOURTH RATING ON 10 TREATMENT CASES

	Case number 1	2	3	4	5	6	7	8	9	10	No Ss P	No Ss A	No Ss G	Case numbers rated G
Locomotion														
Chin up	P	P	P	P	P	P	P	P	P	P	10	0	0	0
Chest up	P	P	P	P	P	P	P	P	P	P	10	0	0	0
Sits with support	P	P	P	P	P	P	P	P	P	P	10	0	0	0
Sits alone	P	P	P	P	P	P	P	P	P	P	10	0	0	0
Creeps	P	P	P	P	P	P	P	P	P	P	10	0	0	0
Stands with support	P	P	P	P	P	P	P	P	P	P	10	0	0	0
Stands alone	P	A	P	P	P	P	P	P	P	P	9	1	0	0
Walks with support	P	P	P	P	P	P	P	P	P	P	10	0	0	0
Walks alone	P	A	P	P	P	P	P	P	P	P	9	1	0	0
Up and down stairs, aided	P	A	P	P	P	P	P	P	P	P	9	1	0	0
Up and down stairs, two steps per tread	G	A	P	P	P	P	P	P	P	P	8	2	1	#1
Up and down stairs alternate treads	A	A	A	A	G	P	A	P	P	P	4	6	1	#5
Runs	P	A	A	A	G	P	A	P	P	P	5	5	1	#5
Skips	A	A	A	A	A	A	A	A	P	A	1	9	0	0
Dressing														
Cooperates with removal of clothes	P	P	P	P	P	P	P	P	P	P	10	0	0	0
Removes coat, unbuttoned	P	A	G	P	P	P	P	P	P	P	8	2	1	#3
Unbuttons and removes coat	P	A	G	P	P	P	P	P	P	P	8	2	1	#3
Removes shoes and stockings, unfastened	P	A	G	P	P	P	P	P	P	P	8	2	1	#3
Unfastens and removes stockings and shoes	P	A	G	P	P	P	P	P	P	P	8	2	1	#3
Removes rest of clothes, assisted	P	A	G	P	P	P	P	P	P	P	8	2	1	#3
Unfastens and removes rest of clothes	P	A	G	P	P	P	P	P	P	P	8	2	1	#3
Cooperates with dressing	P	P	P	P	P	P	P	P	P	P	10	0	0	0
Puts on coat, assisted	P	A	G	P	P	P	P	P	P	P	8	2	1	#3
Puts on coat, unassisted	P	A	G	P	P	P	P	P	P	P	8	2	1	#3
Buttons coat	P	A	A	P	P	P	G	P	P	P	7	3	1	#7
Puts clothes on, assisted	P	A	G	P	P	P	P	P	P	P	8	2	1	#3
Puts clothes on, unassisted	P	A	A	P	P	P	P	P	P	P	8	2	0	0
Fastens clothes	P	A	A	P	P	P	G	P	P	P	7	3	1	#7
Puts on shoes and stockings, assisted	P	A	G	P	P	P	P	P	P	P	8	2	1	#3
Puts on shoes and stockings, unassisted	P	A	G	P	P	P	P	P	P	P	8	2	1	#3
Laces and ties shoe laces	G	A	G	P	P	P	G	P	P	P	6	4	3	#1, 3, 7
Brushes teeth	P	A	A	P	P	P	P	P	P	P	8	2	0	0
Combs hair	G	A	A	P	P	P	A	P	P	P	6	4	1	#1

TABLE 3 (*continued*)

	Case number										No. Ss	No Ss	No Ss	Case numbers rated G
	1	2	3	4	5	6	7	8	9	10	P	A	G	
Bathing														
Washes and dries hands	P	A	A	P	P	P	P	P	P	P	8	2	0	0
Washes and dries face	P	A	A	P	P	P	P	P	P	P	8	2	0	0
Washes and dries neck and ears	P	A	A	P	P	P	G	P	P	P	7	3	1	#7
Bathes self, supervised	A	A	A	G	A	G	A	P	P	P	3	7	2	#4, 6
Bathes self, unsupervised	A	A	A	A	A	A	A	A	G	P	1	9	1	#9
Eating														
Carries to mouth successfully	P	P	P	P	P	P	P	P	P	P	10	0	0	0
Holds and drinks from cup, unassisted	P	A	P	P	P	P	P	P	P	P	9	1	0	0
Begins to use spoon—spills	P	A	P	P	P	P	P	P	P	P	9	1	0	0
Uses spoon—no spills	P	A	P	P	P	P	P	P	P	P	9	1	0	0
Uses fork	P	A	A	P	P	G	P	P	P	P	7	3	1	#6
Uses knife to spread	A	A	A	G	A	G	A	P	P	P	3	7	2	#4, 6
Uses knife to cut	A	A	A	G	A	A	A	P	G	P	2	8	2	#4, 9
Communication														
Laughs, cries, vocalizes	P	P	P	P	P	P	P	P	P	P	10	0	0	0
Begins to use words	P	P	P	P	P	P	P	P	P	P	10	0	0	0
Uses words	P	A	G	P	P	P	P	P	P	P	8	2	1	#3
Uses phrases	P	A	A	P	P	P	P	P	P	P	8	2	0	0
Uses sentences	P	A	A	P	P	P	A	P	P	P	7	3	0	0
Gesticulates	P	P	P	P	P	P	P	P	P	P	10	0	0	0
Scribbles	P	P	P	P	P	P	P	P	P	P	10	0	0	0
Writes or prints from copy	A	A	A	G	G	P	G	G	P	P	3	7	4	#4, 5, 7, 8
Composition—letter	A	A	A	A	A	A	A	P	P	P	3	7	0	0
Tells name	P	A	A	P	P	P	P	P	P	P	8	2	0	0
Prints or writes first name	A	A	A	P	G	P	P	P	P	P	6	4	1	#5
Writes full name	A	A	A	G	A	P	A	P	P	P	4	6	1	#4
Control of excretion														
Bowel control partly established	P	A	P	P	P	P	P	P	P	P	9	1	0	0
Bowel control established	P	A	P	P	P	P	P	P	P	P	9	1	0	0
Daytime bladder control partly established	P	L	P	P	P	P	P	P	P	P	10	0	0	0
Daytime bladder control established	P	A	P	P	P	P	P	P	P	P	9	1	0	0
Night-time bladder control established	P	A	A	P	P	P	P	P	P	P	8	2	0	0
Total performances gained per subject	3	0	13	5	4	3	5	1	2	0				
Group totals											473	147	36	All but #2

Key:

P	Present when study began	G	Gained during study
A	Absent during study	L	Lost during study

TABLE 4

RECORD OF CHANGES FROM FIRST TO FOURTH RATING ON 10 NON-TREATMENT CASES

	Case number										No Ss	No Ss	No Ss	Case numbers
	1	2	3	4	5	6	7	8	9	10	P	A	G	*rated G*
Locomotion														
Chin up	P	P	P	P	P	P	P	P	P	P	10	0	0	0
Chest up	P	P	P	P	P	P	P	P	P	P	10	0	0	0
Sits with support	P	P	P	P	P	P	P	P	P	P	10	0	0	0
Sits alone	P	P	P	P	P	P	P	P	P	P	10	0	0	0
Creeps	P	P	P	P	P	P	P	P	P	P	10	0	0	0
Stands with support	P	P	P	P	P	P	P	P	P	P	10	0	0	0
Stands alone	P	P	P	P	P	P	P	A	P	P	9	1	0	0
Walks with support	P	P	P	P	P	P	P	P	P	P	10	0	0	0
Walks alone	P	P	P	P	P	P	P	A	P	P	9	1	0	0
Up and down stairs, aided	P	P	P	P	G	P	P	A	P	P	8	2	1	#5
Up and down stairs, two steps per tread	P	P	P	P	G	P	P	A	P	P	8	2	1	#5
Up and down stairs alternate treads	G	A	P	P	G	G	P	A	P	P	5	5	3	#1, 5, 6
Runs	P	P	P	P	A	P	P	A	P	P	8	2	0	0
Skips	A	A	P	A	A	A	A	A	A	A	1	9	0	0
Dressing														
Cooperates with removal of clothes	P	P	P	P	P	P	P	P	P	P	10	0	0	0
Removes coat, unbuttoned	P	A	P	P	P	P	P	P	P	P	9	1	0	0
Unbuttons and removes coat	P	A	P	P	P	P	P	P	P	P	9	1	0	0
Removes shoes and stockings, unfastened	P	A	P	P	P	P	P	P	P	P	9	1	0	0
Unfastens and removes stockings and shoes	P	A	P	P	P	P	P	P	P	P	9	1	0	0
Removes rest of clothes, *assisted*	P	A	P	P	P	P	P	P	P	P	9	1	0	0
Unfastens and removes rest of clothes	P	A	P	P	P	P	P	P	P	P	9	1	0	0
Cooperates with dressing	P	P	P	P	P	P	P	P	P	P	10	0	0	0
Puts on coat, assisted	P	A	P	P	P	P	P	P	P	P	9	1	0	0
Puts on coat, unassisted	P	A	P	P	P	P	P	P	P	P	9	1	0	0
Buttons coat	G	A	P	P	P	P	P	P	P	P	8	2	1	#1
Puts clothes on, assisted	P	A	P	P	P	P	P	P	P	P	9	1	0	0
Puts clothes on, unassisted	G	A	P	P	P	P	P	P	P	P	8	2	1	#1
Fastens clothes	G	A	P	P	P	P	P	P	P	P	8	2	1	#1
Puts on shoes and stockings, *assisted*	P	A	P	P	P	P	P	P	P	P	9	1	0	0
Puts on shoes and stockings, unassisted	G	A	P	P	P	P	P	P	P	P	8	2	1	#1
Laces and ties shoe laces	A	A	P	P	P	P	P	P	P	P	8	2	0	0
Brushes teeth	G	A	P	P	P	P	P	P	P	L	8	2	1	#1
Brushes hair	A	A	P	P	P	P	G	P	P	P	7	3	1	#7

TABLE 4 (*continued*)

	Case number 1	2	3	4	5	6	7	8	9	10	No Ss P	No Ss A	No Ss G	Case numbers rated G
Bathing														
Washes and dries hands	P	A	P	P	P	P	P	P	P	P	9	1	0	0
Washes and dries face	A	A	P	P	P	P	P	P	P	P	8	2	0	0
Washes and dries neck and ears	A	A	P	P	P	P	P	P	P	P	8	2	0	0
Bathes self, supervised	A	A	G	P	P	P	P	P	P	P	7	3	1	#3
Bathes self, unsupervised	A	A	A	P	P	P	P	P	P	P	7	3	0	0
Eating														
Carries to mouth successfully	P	P	P	P	P	P	P	P	P	P	10	0	0	0
Holds and drinks from cup, unassisted	P	P	P	P	P	P	P	P	P	P	10	0	0	0
Begins to use spoon—spills	P	P	P	P	P	P	P	P	P	P	10	0	0	0
Uses spoon—no spills	P	P	P	P	P	P	P	P	P	P	10	0	0	0
Uses fork	A	A	P	P	P	P	P	P	P	P	8	2	0	0
Uses knife to spread	A	A	P	P	P	P	P	P	P	P	8	2	0	0
Uses knife to cut	A	A	P	A	P	P	P	P	P	P	7	3	0	0
Communication														
Laughs, cries, vocalizes	P	P	P	P	P	P	P	P	P	P	10	0	0	0
Begins to use words	A	P	P	P	P	P	P	P	P	P	9	1	0	0
Uses words	A	P	A	P	P	P	P	P	P	P	8	2	0	0
Uses phrases	A	P	A	P	P	P	P	P	P	P	8	2	0	0
Uses sentences	A	P	A	P	P	P	P	P	P	P	8	2	0	0
Gesticulates	P	P	P	P	P	P	P	P	P	P	10	0	0	0
Scribbles	P	P	P	P	P	P	P	P	P	P	10	0	0	0
Writes or prints from copy	A	A	A	P	A	P	P	P	P	P	6	4	0	0
Composition—letter	A	A	A	A	A	A	P	P	P	P	4	6	0	0
Tells name	A	P	A	P	P	P	P	P	P	P	8	2	0	0
Prints or writes first name	A	A	A	P	P	P	P	P	P	P	7	3	0	0
Writes full name	A	A	A	G	P	P	P	P	P	P	6	4	1	#4
Control of excretion														
Bowel control partly established	P	L	P	P	P	P	P	P	P	P	10	0	0	0
Bowel control established	P	A	P	P	P	P	P	P	P	P	9	1	0	0
Daytime bladder control partly established	P	P	P	P	P	P	P	P	P	P	10	0	0	0
Daytime bladder control established	G	A	P	P	P	P	P	P	P	P	8	2	1	#1
Night-time bladder control established	P	P	P	P	P	P	P	P	P	P	10	0	0	0
Total performances gained by subjects	7	0	1	1	3	1	1	0	0	0				
Group totals											526	94	14	#1, 3, 4, 5, 6, 7

Key.

P	Present at beginning of study	G	Gained during study
A	Absent during study	L	Lost during study

TABLE 5
COMPARATIVE NUMBER OF ABILITIES LACKED AND GAINS MADE, AND THE NUMBER OF SUBJECTS WHO LACKED ABILITIES AND MADE GAINS IN BOTH GROUPS

Category	Group	Total abilities lacked No	Ss	Total gains made No	Ss	Percentage gained No	Ss
Locomotion	Treatment	25	9	3	2	12	22
	Control	22	9	5	3	23	33
	T—C	3	0	–2	–1	T/C–.52	–.50
Dressing	Treatment	40	4	17*	3	43	75
	Control	25	3	6	2	24	67
	T—C	15	1	11	1	T/C 1.79	1.12
Bathing	Treatment	23	9	4	4	17	44
	Control	11	3	1	1	9	33
	T—C	12	6	3	3	T/C 1.78	1.33
Eating	Treatment	21	8	5	3	24	38
	Control	7	3	0	0	0	0
	T—C	14	5	5	3	T/C Indet	Indet.
Communication	Treatment	33	8	7	5	21	63
	Control	26	6	1	1	4	17
	T—C	7	2	6	4	T/C 5.25	3.70
Control of excretory functions	Treatment	5	2	0	0	0	0
	Control	3	2	1	1	33	50
	T—C	2	0	–1	–1	T/C 0	0
Total treatment		147		36		25	
Total control		94		14		15	
Total T—C		53		22		T/C 1.67	

*Twelve of these gains were made by one subject

12 per cent of the total number of abilities lacking were gained (i. e., 3 gains divided by 25 abilities lacking) and 22 per cent of the treatment subjects gained (i. e., 2 out of 9 subjects). Similarly the second row reads: In the control group 22 abilities were lacking in the category of locomotion among 9 subjects; 5 abilities were gained by 3 subjects; which means that 23 per cent of the possible gains were made by 33 per cent of the subjects. In the third row: Three more abilities were lacking in locomotion in the treatment group than in the non-treatment group, there was no difference in the number of subjects lacking abilities in locomotion, 2 less gains were made by the treatment group compared with the non-treatment group; 1 less subject in the treatment group gained in comparison with the non-treatment group, (and in the last two columns) using

the treatment-group percentage as a base, and dividing by the percentage of the non-treatment group (i e., T/C or 12 divided by 23), the treatment group gained in ratio 52 less in percentage of abilities and also .50 less in percentage of subjects. In other words, during the course of the study the non-treatment group gained more in locomotion than did the subjects under treatment. There were more gains made and there were more subjects who gained. The rest of the table may be read in like manner.

VI. Discussion of Results

In four of the six general categories the treatment group made a greater percentage of gains than did the non-treatment group, namely, in dressing, bathing, eating, and communication. In two of the general categories, the non-treatment group made a greater percentage of gains than did the treatment group, namely, in locomotion and in control of the excretory functions In the entire list of performances the treatment group gained 25 per cent of the abilities lacked at the beginning of the study, whereas the non-treatment group gained 15 per cent of the abilities lacked. The treatment group made, therefore, 1 7 times as many gains as the non-treatment group

This superiority of the treatment group seems small, both absolutely and relatively. The question must now be raised whether even this small superiority can be attributed to the effects of treatment. A conclusive answer does not seem possible in view of certain further differences existing between the two groups other than the factor of treatment.

In the first place, the treatment group was, on the average, 11.5 years younger than the non-treatment group One might expect that the younger group, other things being equal, would make more gains on account of the greater possibility for growth, but on the other hand, the older subjects might be expected to have greater motivation, so that it seems difficult to decide where the advantage would be with regard to age In the second place, the treatment group is more severely handicapped. In the third place, there is a difference in type of involvement predominating in the two groups There is a preponderance of quadriplegias in the treatment group and of cases of general incoordination in the non-treatment group. We know of no way of evaluating these last two factors so as to determine whether the differences favor one group more than the other The other factors of mental age, intelligence quotient, and type are about equal in the two groups.

Another difficulty in evaluating the effect of treatment is found in evaluating the gains requiring manipulation made by the subjects with paraplegia The motor disabilities in such subjects are in the legs, and since treatment is applied only to affected parts it is difficult to see how gains in manipulation in subjects with paraplegia can be attributed to treatment. However, an aura from the treatment, probably arising from the special interest in any child receiving treatment, could perhaps augment or accelerate manipulative facility.

There are, furthermore, other additional factors that might be considered as affecting the gains, and which do not readily lend themselves to tabulation. One of these is motivation. In the treatment group, for instance, the two subjects making the three gains in walking were young boys from the same cottage whose motivation was excellent because of the good-natured rivalry between them, fostered by the physical therapist Another factor to be considered is the influence of change of residence. Subject 4 in the treatment group was transferred from a cottage for children of low mentality to one for patients somewhat older and brighter, where relatively more independence is expected The increased self-reliance expected may have contributed to the gain he made in the category of bathing

Still another uncontrolled factor is that opportunities for learning were not the same in different situations This is especially apparent in the category of eating Knives and forks are provided in addition to spoons in the dining rooms for older and brighter patients, but not in some of those for younger and low-grade patients for the reason that the young low-grade patients do not handle them safely or effectively. Hence there is a lack of opportunity for improvement for some subjects in the category of eating This would affect Subjects 1, 3, and 5 in the treatment group, and 1 and 2 in the nontreatment group A change of dining room, with consequent greater opportunity, is believed to have influenced the gains of Subject 4 in the treatment group. On the other hand, Subjects 6 and 8 in the treatment group and Subject 4 in the control group did not lack the opportunity to use knives and forks had they so desired

A total of three losses is recorded Subject 2 in the treatment group lost in the category of control of excretory functions Subject

2 in the control group lost an item in the same category. These losses might be due to borderline responses or low mentality. Subject 10 in the non treatment group became apprehensive about brushing her false teeth, since she feared that in her palsy she might drop and break them, and this service now has to be done for her

In recapitulation, the effect of training other than that involved in muscle training is not allowed for in this study It is probable that some of these social abilities might have been gained in time as a result of the cottage training alone which is a part of the institution's daily program For instance, the 12 gains made in dressing by Subject 3 in the treatment group were probably facilitated by such training On the other hand, Subject 7, who is over 25 years of age, and has always been quite self-dependent, also made gains in dressing, and this suggests that his gains might be due to the special treatment So in each case, whether the gain in ability results from treatment or training or growth depends on a number of factors and no attempt is made here to particularize the actual reason for the gain. All the subjects were of sufficient life age that, had they been mentally and physically normal, all the performances could reasonably have been expected of them

With respect to the mental ages of the subjects, the situation is somewhat more complicated Subjects with mental ages under 6 years (Subjects 1, 2, and 3 in the treatment group and Subjects 1 and 2 in the control group), and with life ages of at least 6 years, and without physical handicaps, could reasonably be expected to have all the abilities listed, except, perhaps, bathing, using a knife, writing or printing Those with mental ages of 9 years or above could reasonably be expected to have all the abilities listed, under normal physical conditions. This leaves four subjects in the treatment group and three subjects in the control group with mental ages between 6 and 9 years for whom there might be some doubt as to their mental ability for the performances required Actually, at least one subject in this borderline mental age group does each of the questioned performances with the exception of "composition" With these exceptions, then, it seems reasonable to expect every subject to acquire each ability listed, barring the limitations imposed by the physical handicap.

In the year and a half during which this study was in progress the subjects, of course, increased a year and a half in life age In the younger subjects this may have involved an increasing physical ability, through mere growth, to cope with the situations presented. In the older subjects it may have meant a corresponding decrease in physical facility, especially in view of the fact that the mentally deficient tend to age early During this time the mental ages of the groups in some cases made no appreciable gains and in others considerable gain was made. Subject 2 in the treatment group is considered to have reached the limit of his mentality and no gain is recorded. For Subject 9 in the same group, however, a gain from mental age 10 years to 12 years was recorded Two years' mental growth in a year and a half is extraordinary mental growth, even for the birth-injured mentally retarded, who not infrequently show unusual mental development.

In the light of these considerations, what final conclusions are justifiable? (1) The treatment group makes a somewhat greater gain than the non-treatment group (2) In view of other differences between the groups, which have just been discussed, it would not seem justifiable to attribute this superiority to the treatment alone It may have been due to the treatment, or it may have been due to other factors, or it may have been that the influence of the treatment was somewhat greater than has been recorded, but it was submerged by other factors It may also be that the schedule of performances fails to elucidate significant progress.

It is of interest to compare these conclusions with those presented by Martz and Irvine in a recent report (8) The aim of their study was to estimate the results of physical and mental training on a group of 18 mentally deficient children with birth injuries The general conclusion of their study, although it did not indicate clearly the method used for estimating improvement, was that there was little marked improvement in the group as a whole, though some individuals made considerable improvement

Finally, it should be emphasized that our conclusions do not imply that no improvement occurred as a result of the physical therapy. The purpose of this muscle training is to modify the specific neuromuscular mechanisms essential to the motor acts which we have considered It has not thus far concerned itself specifically with capitalizing motor improvement for practical use. This study, on the contrary, has examined precisely this phase of motor performance, for we were concerned with the spontaneous practical end results of any motor changes that may have occurred through the treatment

VII SUMMARY AND CONCLUSIONS

The purpose of this study was to determine whether birth-injured children incapable of certain socially significant performances because of motor handicaps acquire these abilities as a result of muscle training. A group of subjects receiving physical therapy was compared with a like group not receiving such treatment with respect to their abilities on a list of performances considered useful for social independence in everyday life

This problem was one of several undertaken at the Vineland Laboratory in an attempt to measure such changes as might occur in birth-injured subjects who have been receiving muscle training for several years in an institution for mentally deficient patients The study is a preliminary report recording changes that have occurred during a year and a half of muscle training

The present results suggest that there is slightly more improvement in the treatment group. However, this excess is small and there are many uncontrollable factors outside the treatment (such as age, degree of handicap, type of involvement, growth, motivation, and cottage training; factors which cannot be precisely evaluated). The greater progress in the treatment group therefore cannot conclusively be attributed to the influence of the treatment alone This does not imply that improvement did not occur in other aspects of motor performances The present study was concerned only with changes in ability to perform motor acts deemed necessary for social independence in a simple social group Moreover, the examination schedule used was not exhaustive, but only representative, and may not have measured the important changes, or may have been too coarse an instrument to record such other progress as may have been made

Since substantial gains were made by some of the non-treatment group, one is justified in the further conclusion that some cases of dyskinesia improve with age and without specific treatment

The program of muscle training in these individuals is one which is carried out over a long period of time, beginning with the simplest motions of the individual joints which, after a year or two, or whenever the patient seems ready to go further, are combined in two or more joints. Following another indefinite period of time, the patients are taught to apply these movements to socially useful acts.

No conclusion can be drawn with regard to the response of mentally normal children to treatment on the basis of response in this mentally deficient group. It may be that the period of time necessary for training children in the application of these motions for useful activities would be longer in the mentally deficient than in the mentally normal

The experience gained from treating the patients in a mentally deficient group may be of help in the training of normal children whose physical ages correspond to the mental ages of the deficient children.

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L'INFLUENCE DE L'ENTRAÎNEMENT DES MUSCLES SUR LES ENFANTS FAIBLES D'ESPRIT BLESSÉS À LA NAISSANCE

(Résumé)

Cette étude est un premier rapport d'un plus grand développement de l'effort personnel comme résultat de l'entraînement des muscles chez des sujets faibles d'esprit blessés à la naissance Dix sujets de cette description recevant de l'entraînement, et un groupe de contrôle de dix sujets semblables qui n'ont pas reçu cet entraînement des muscles, ont été comparés dans un programme d'actes quotidiens tels que la locomotion, l'habillement, les bains, la nourriture, etc. Pendant la période de l'entraînement le groupe recevant de l'entraînement a gagné 25 pour cent d'un groupe d'habiletés qu'il n'a pas eu au commencement de l'étude, tandis que le groupe de contrôle en a gagné de la même manière 15 pour cent On discute les résultats à l'égard de tels variables que l'âge mental, le degré de l'infirmité, la motivation, le type de complication motrice, la croissance et l'entraînement occasionnel à la maison. Il y a une implication que l'expérience gagnée dans l'entraînement de ces malades faibles d'esprit peut être utile dans l'entraînement des malades mentalement normaux

LONGWELL

DER EINFLUSS DER MUSKELÜBUNG AUF DIE DURCH DIE GEBURT VERLETZTEN GEISTESSCHWACHEN KINDER

(Referat)

Dieses Studium ist der erste Bericht über die Verbesserung der Selbsthilfe durch Muskelübung bei geistesschwachen Kindern, die durch Geburt verletzt wurden. Zehn solche Vpn erhielten Behandlung, und eine Kontrollgruppe von zehn ähnlichen Vpn., die aber keine Muskelübung gehabt hatten, wurden hinsichtlich einer Reihe von alltäglichen Akten, wie freiwillige Bewegung, Anziehen, Baden, Essen, und dergleichen, verglichen. Während der Übungsperiod gewann die Übungsgruppe 25 Prozent von einer Gruppe von Fähigkeiten, die sie zu Anfang des Studiums nicht besassen, während die Kontrollgruppe gleicherweise 15 Prozent gewann Die Ergebnisse werden hinsichtlich solcher Variablen wie Alter, geistiges Alter, Grad der Ungleichheit, Motivierung, Art der Motorverwicklung, Wachstum und nebensächliche Übung zu Hause, besprochen Es stellte sich die Andeutung heraus, dass die Erfahrung, die durch die Behandlung solcher geistesschwachen Patienten gewonnen wurde, brauchbar bei der Erziehung geistesnormaler Patienten sein dürfte

LONGWELL

TALKATIVENESS IN STUTTERING AND NON-STUTTERING CHILDREN*

From the Psychological Service Center, St Louis, Missouri

H. MELTZER

From a rough survey of authoritative books[1] on stuttering one could easily get the impression that talking is an unimportant function for the stutterer. At any rate none of these books reports anything about talkativeness, either the amount, the speed, or the nature of talkativeness in stutterers That the talking of stuttering children is different from the talking of non-stuttering children is obvious. What are these differences? Are they differences in kind, differences in speed, or differences in nature?

THE PRESENT STUDY

The present study represents an attempt to throw some light on the nature of talkativeness in stuttering children by analyzing the differences in number of words used and the time taken 'by 50 *stuttering children and a control group of 50 children in responding* to the ten ink blots which compose the Rorschach personality test It is a by-product of the study of personality differences of stutterers as indicated by this test (10).

Procedure The number of words used by a child in responding to all ten ink blots was taken as a measure of his talkativeness Both the nature of the blots as well as the manner of administering the test,[2] it will be remembered, tend to evoke relatively free associations from the subject. The associations given, that is, are characteristically personality responses Time was kept with a stop watch and is reported in terms of seconds taken to respond to all blots.

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*Accepted for publication by Carl Murchison of the Editorial Board and received in the Editorial Office, September 7, 1934

[1] Of the 25 books surveyed 13 were written in German, 9 in English, and 3 in French List includes recent works of Twitmeyer, Stinchfield, and Travis, as well as *earlier works by such contributors as Scripture, Gutzmann*, Guttmann, Froschels

[2] For details see studies by Rorschach (13, 14), Beck (2, 3, 4), and Meltzer (10, 11)

Rate is reported in terms of words given in time taken. The nature of talkativeness was investigated as follows: (*a*) an analysis of differences between stuttering and non-stuttering children on certain Rorschach factors, (*b*) the analysis of the differences in the correlation of talkativeness and certain Rorschach factors in the groups of children, and (*c*) the analysis of the differences in the relationship between talkativeness and certain psychological, social, and educational factors

The examinations of the stuttering and control groups were started on January 20 and finished May 13, 1932. Other data about the children then obtained were intelligence test results, school, family, and developmental histories including speech histories.

The Subjects All stuttering children from 15 of 23 speech centers in a large city school system were examined. This number represented all the stutterers who were being instructed by three of the five speech teachers doing this work at the time. This manner of selecting the subjects practically assured the adequacy of the sampling. The differentiations made by some investigators between stammering, described as a freezing or deadlocking in which no sound is uttered for a relatively long time, and stuttering, described as uncontrolled frequent repetition of some sound or syllable, was not made A large number of children did both. The control group of children were hand-picked to equate for sex, age, grade, school, and intelligence[8] For the present purposes it is enough to summarize these data as follows. Of the 50 stutterers matched with the control group 38 or 76% were boys and 12 or 24% girls The ages range from 8 to 16 in the stuttering group and from 8 to 17 in the control group, the mean age of the stutterers being 12.46 and the mean age of the control group being 12 67 The mean IQ for both groups was 97 2. The range of onset of stuttering was from the time the child first talked to 13 In practically two-thirds of the cases the onset took place before 8

RESULTS

1. *Differences in Amount and Rate of Talkativeness*

a. Differences in amount of talkativeness. The median number of words used by the 50 stuttering children in responding to the Rorschach test is 200 words, whereas the median for the control group is only 135. This, as indicated in Table 1, represents a fairly reliable statistical difference in favor of the stuttering children of 65 words The mean number of words used by the stuttering children is 280 words and by the control group is 169 40. The percentage of stuttering children who equal or exceed the mean of the control group is 63 16, the percentage in terms of the median is 82.80 The discrepancy between the median and mean comparisons is largely the result of differences in extreme scores found in the two groups The largest number of words given by a non-stutterer is 663, the largest number given by a stuttering child is 1045 The second largest score in the stuttering group is 868, in the control group it is 500 Thereafter both distributions are fairly continuous The smallest number of words given by a stutterer was 74; by a child from the control group, 26 Sixteen children from the control group used less than 100 words. Only three stuttering children did so.

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[8] For more detailed description of subjects in both control and experimental groups of children see (11)

The foregoing results clearly indicate that on the relatively free associations evoked by the Rorschach test stuttering children are significantly more talkative than non-stuttering children. The percentage of difference is 38 80

This corresponds very closely with the differences found by Hawthorne (7) in his analysis of words used by a stuttering group of 68 children and a control group of 250 in response to the three questions: (1) What did you have for breakfast this morning? (2) What did you have for dinner last night? (3) What game do you like best and how do you play it?

The mean number of words in answer to these questions used by the stutterers was 101 02 and the mean used by the control group, 68.02 The difference of 33 is statistically reliable (Diff./S D.Diff. = 6 07). Calculating from the results given by Hawthorne the percentage of difference is 39 04.

Whether the differences in the words used would be more or less in favor of the stuttering children if the associations were significantly more controlled than those evoked by either the three questions used by Hawthorne or the responses to the Rorschach test used in the present study can only be guessed The advantage of the use of the Rorschach test is that it makes possible an analysis of the nature of talkativeness in terms of the psychodiagnostics of Rorschach as well as correlations with other factors.

b. Differences in speed and rate of talkativeness The median time taken by stuttering children to respond to all the ink blots of the Rorschach differs little from the median time taken by the control group, and the relatively small difference found is statistically insignificant. The statistical results are reported in Table 1. Both the largest and smallest amounts of time were taken by stuttering children. The range in the stuttering children was from 250 to 2949 seconds, the range in the control group was from 400 to 2749 seconds.

If the number of words used in the total time taken is considered the index of rate of talkativeness, the mean rate for stuttering children is found to be significantly greater than the rate for the control group—51.8% greater. 83.84% of the stuttering children equal or exceed the median rate of the control group

2. *Differences in Nature of Expressiveness* Differences in the nature of expressiveness will be indicated in two ways: (*a*) in terms of differences on selected[4] Rorschach factors as reported in Table 2 and (*b*) in terms of the correlations of these factors with talkativeness

The meanings of the symbols for the Rorschach factors included and the psychological processes they indicate may be summarized as follows:

ΣW—Number of whole responses as determined by Beck's method, indicative of interest in and capacity for abstract thinking or associational synthetic mental activity

R_1—Scores representing the number of all responses regardless of the nature of content

M—Movement responses, indicative of trend to fantasy life, of withdrawal into self and also capacity for creative thinking

C—Color responses, indicative of egocentricity, irritability, manic trend

FC—Form-color, a combination in which form is dominant, indicative of adaptable affectivity

ΣCF—Numerical evaluation for color responses,[5] indicative of extent of exteriority.

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[4] The mean differences on practically all Rorschach factors as well as other related statistics are reported in (1)

[5] Obtained by giving values 1 5 for a C, 1 for a CF and 5 for an FC

TABLE 1

DIFFERENCES IN AMOUNT AND SPEED OF TALKATIVENESS

Function		Median	P E	Diff	PE_{diff}	$\frac{\text{Diff.}}{PE_{diff}}$	Overlapping % S=or>C Average	
Number of words used	S	200 00	24 63	65 00	29 22	2 22	Med	82 80
	C	135 00	15 70				Mean	63 16
Time in seconds	S	925 00	82 70				Med.	50 53
	C	962 50	91 90	37 50	123 60	303		
Rates	S	230	01	094	0179	4.24	Med	83 84
	C	138	0146					

TABLE 2

DIFFERENCES IN NATURE OF EXPRESSIVENESS

		ΣW	R₁	M	C	FC	ΣCF	F(C)	F+	(O-P)
Overlapping % S=or>C Median		72 9	80 8	100	100	43 5	77 5	100	20	56 20
% Mean differences*	S	56 65	14.47	25 64	12 41		16 62	23 42		1 70
	C					14 49			19 16	

*Means are placed on line with S if difference is in favor of the stuttering group, on line with C when difference favors the control group

F(C)—Chiaroscuro responses dictated by differential shadings of gray and sometimes other colors, indicative of absorption in the far away or disposition to depression.

F+—Sharply perceived forms, indicative of clearness of perception, of concentration capacity, or of voluntary control of intellectual functioning.

(O-P)—Originality, determined on the basis of frequency distribution

R—Scores representing the number of responses having content

a Differences on some Rorschach factors The differences between stuttering and non-stuttering children on these factors are reported in terms of overlapping as well as percentage of mean differences in Table 2.

Stuttering children, then, name many more whole responses; many of these are vague perceptual wholes; they give many more non-content responses, are more expressive in both measures of interiority as well as exteriority, and show more absorption in the far away or disposition to depression. On the factors selected the control group surpasses the stuttering children in measures of adaptable affectivity (*FC*) and clearness of perception, concentration capacity or voluntary control of intellectual functioning (*F+*).

b. Correlation of Rorschach factors with talkativeness. How the foregoing Rorschach factors correlate with talkativeness for stuttering and non-stuttering children is indicated in Table 3.

TABLE 3

CORRELATIONS OF TALKATIVENESS WITH SOME RORSCHACH FACTORS

Factor	Stutterers	Non-stutterers
M	32±.085	.51± 07
C	137± 09	.18± 09
ΣW	.178± 09	22± 09
R_1	82± 03	89± 019
%F	—.139± 093	— 24± 089
(O-P)	129± 09	35± 08
R	82± 03	24± 08

Regardless of the positive or negative direction of the relationship, talkativeness correlates higher with Rorschach factors in non-stuttering children than in stutterers. In all but one factor the correlation is larger positively. In the one factor which correlates negatively with talkativeness the correlation is more negative for the non-stuttering group

The very high correlation of R_1 with talkativeness is not at all surprising if it is remembered that R_1 is a measure of all responses made regardless of relevance In the light of the differences in expressiveness and the nature of expressiveness between stuttering and non-stuttering children reported in Table 2, the somewhat higher positive correlation of ΣW, R_1, $(O\text{-}P)$, M, and C with talkativeness in the control group, the significantly higher correlation with R, and the somewhat higher negative correlation of $F+$ with talkativeness in the stuttering group are in accord with logical anticipation.

The higher correlation of talkativeness with movement responses than with color responses is in accord with the general impression one obtains in giving the Rorschach test. Generally, it takes more words to describe a movement response than a color response Furthermore, it is in accord with the impression one gets that generally movement responses are a more valid index of expressiveness than are color responses

On the basis of an observational study of 33 young children ranging in ages from 27 to 59 months, Goodenough (6) reports a correlation of .60 between talkativeness and extroversion. This is not in agreement with our results if M, Rorschach's index of interiority, and C, his measure of exteriority, are considered as synonymous with introversion and extroversion, as measured by inventories or by observational studies of behavior. This assumption is unwarranted to the extent that verbal expressiveness on Rorschach is different from or not consistent with either the answers on inventories or the types of expressive movements observed by Goodenough and her associates

3. *Differences in the Nature of Talkativeness.*

a Previous studies on the nature of talkativeness. About the nature of talkativeness described in vague general terms much has been written[6] About the nature of it in terms of quantitative relationships with other tangible and significant psychological and social factors very little is found in psychological literature. The two studies which contain some data which are somewhat comparable to the relationships to be described forthwith in the present study are those of Goodenough (6) and Meltzer (12) In the former, the subjects used were very young children and the method used is observational by the short sample technique The subjects used in the latter study were 333 pupils from the fourth grade through the high schools from five educational systems located in or near New York City The method used was one purported to evoke all the meanings a list of well selected social concepts[7] had to the individuals examined. The subject was instructed to tell everything each concept meant to him. Illustrative of the concepts used were: Democracy, Imperialism, an Interdependent World, Industrial Revolution

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[6] Cf (12) for partial list and further reference to such literature

Comparisons with and interpretations of these studies will be more intelligently made if the following facts are kept in mind. In all studies under consideration the group approach in examining or observing was not used. Each child, that is, was separately examined or observed The age and grade range of the children used in the study of social concepts more closely corresponds to the age and grade ranges of children used in the present study The associations evoked in the social-concept study are the most controlled, those evoked by the Rorschach test relatively most free.

b Relationships with talkativeness on the Rorschach test. The relationships between talkativeness in response to the Rorschach test and the developmental, social, economic, and educational factors investigated in this study are reported in Table 4

The correlation of talkativeness with time is the only one which

TABLE 4

CORRELATIONS OF TALKATIVENESS WITH PSYCHO-SOCIAL FACTORS

Factor	Stutterers	Non-stutterers
C A	—10± 10	25± 09
M A.	—14±.10	07± 09
Occupational status	—17± 10	—31± 10
Grade status	05± 094	.42± 078
Time	.81± 03	54± 04

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[7] Cf. (12) for a fuller description of the relevant findings than is herein contained and (9) for a full description of how the concepts used were selected.

is relatively higher for stuttering children than for the control group. The differences in the correlations in the two groups of children are probably due to the large number of vaguely perceived wholes and other non-content responses,[8] including a larger number of qualifying phrases given by stuttering children and the larger number of more sharply perceived forms given by the children from the control group.

Practically all other correlations are relatively low If the other correlations reported in Table 4 are taken at their face value, the data indicate that the relationship of talkativeness for children of the control group as compared with stuttering children is greater in the positive direction with three of the four factors—MA, CA, and grade status—and is greater in the negative direction in only one factor, occupational status. The differences in correlations on the three factors are probably again best explained in terms of the differences between stuttering and non-stuttering children in their non-content responses, vague perceptual wholes, sharply perceived forms and similar Rorschach factors. The most plausible explanation for these differences in terms of motivation is that with increasing age the stuttering child increases his sensitivities and insecurities[9] and as a consequence tends to talk less, whereas the children from the control group, having no such progressive building up of uncertainties, are not so affected; hence the correlation of —.10 for stuttering children and .25 for the control group. The smaller difference in the correlations with MA is understandable if it is remembered that mental age is not as closely related to length of stuttering counted from onset as is CA

The differences in the correlations between talkativeness and occupational status are probably best interpreted in the most obvious manner, namely, occupational status is less a determining factor in verbal expressiveness on the Rorschach test with children from the control group than with stuttering children. And the probable reason is in the greater influence of personality factors in determining the extent of talkativeness in the stuttering children

c. Comparisons with previous studies The differences in correlations of talkativeness with level of mentality reported in the foregoing table are, in the light of the differences in material investigated, consistent with the findings reported in the other aforementioned studies. Goodenough reports a correlation of 49 between talkativeness and mental age, and of .32 with IQ. The correlation of talkativeness about social concepts with IQ is 36± 049. The lower correlation reported in this study is explained easily enough by the differences in kind of association systems, in the Morton Prince sense, evoked. The concept study evokes fairly well-controlled subject matter associations; the present study evokes mood or dispositional association systems as well as content responses

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[8] For a full discussion of differences in content and non-content responses in stuttering children see (10)

[9] Evidence for increased restriction of inner life (*koartieren*) with larger age span of stuttering from age of onset is reported in (10)

Direct comparisons on correlations with CA are not possible The correlation reported for the control group is more like that in the social-concept study, as can be inferred from data reported therein

A decrease in talkativeness with downward shift in occupational status is found in the previous two studies as well as the present one. The data are not reported in a manner which makes direct statistical comparison possible.

Goodenough reports increased talkativeness during the first few months of nursery school attendance and little change thereafter. Talkativeness on social concepts increases steadily with age The mean number of words used ranges from 9.10 in Grade V to 28.37 in Grade XII The relatively high correlation of .42 in the control group is consistent with these findings. The significantly lower correlation of .05 in the stuttering group is probably best interpreted as additional evidence that the talkativeness of stuttering children in terms of relationships with other factors is more complex than with children of the control group

In the study of children's social concepts the correlation reported between talkativeness and grasp of concepts is .31± 03. This corresponds closer with the correlation of 24 between talkativeness and content responses on the Rorschach in stuttering children than the significantly larger correlation of .82 for the control group The reason for the differences in the two groups of this study has already been discussed. The differences between the correlations of the control group in this study and that found in the concept study is due to the differences in the materials and the scoring schemes used.

In the present study any particularized description of form, color, or movement perceived was considered a content response. In the concept study grasp of concept was based on different numerical values given each of a five-fold classification of answers ranging from misconceptions to answers which clearly evidenced a realization of implications as well as a knowledge of the concept

d. Illustrative differences in nature of talkativeness. Adequately to illustrate the differences in the nature of talkativeness between stuttering and non-stuttering children discussed in this paper, one would have to include full samples of responses that space does not permit To add to the concreteness of the picture of differences described the responses of the two most and least talkative children from both groups to the first and sixth blot of the Rorschach test are presented following a brief description of the children

The children Case 1, the most talkative stutterer, is a ten-year-old girl from the fifth grade Her IQ is 109 Skipped once in second grade. Is very industrious and does practically everything asked of her. Has one three-year-old brother Mother and father speak German most of the time.

Case 50, the least talkative stutterer, is an eighteen-year-old girl in the eighth grade. IQ is 104 Repeated first and fourth grades Likes to play with many children and is popular with them. Lives in good residential district Parents own home One of identical twins Other twin does not stutter but tried to affect stutter in order to get into speech class with sister Father stutters. He speaks French but not to the children. Has language conflict and is described by speech teacher as having an inferiority complex. Father is a carpenter. Unemployed for three years. Family life clannish. Other twin brighter but parents insist on same treatment. Case 50 daydreams a great deal and is inclined to show off Just beginning to show interest in boys Parents hold her to standards far beyond her ability

Case 51, the most talkative child from the control group, is a fifteen-year-old boy with an IQ of only 67, who repeated first, fourth, and fifth grades and is now in the sixth Is oldest of five children, three boys and two girls. The girl goes to a Catholic school. Father, formerly a laborer, is now a meat cutter at a down-town store. Children have violent tempers and live in fear of father and each other No family happiness ever observed

Case 100, the least talkative child from the control group, is a fourteen-year-old boy in the sixth grade IQ is 83 Repeated six times in lower grades Likes to play with a few children Family moved seven times in his school career to date, each time into a better district Is oldest of three children. Father is a tailor, unemployed for six weeks at time of examination English and Yiddish spoken at home.

Responses to first, second and sixth blots of Rorschach:

Responses of Case 1

First blot—It looks like a butterfly It has wings and its face is up in the front It is very pretty. It has no color. It is spreading its wing It looks like it is going to fly. It has something like a tail at the bottom. It has a straight line through the middle Its face is very little

Second blot—It looks something like a butterfly. It is all black except at the top and bottom it is a pinkish reddish It is a light gray at the top It has white in the middle It has different designs around the edge In the middle it has little red dots on top of the black In the middle it is a very dark black Around the edge it is a lighter black like that at the top

Sixth blot—I do not know what this is It is a light gray It has something extending out It is a light gray too It has a straight dark line through the middle. It has something extending out from that dark line at the top It has two stickers extending out from the dark line at the top Around the edge it is a darker gray At the bottom it has a little design It is gray It is gray and light gray and black all over It looks like it has wings.

Responses of Case 50

First blot—Looks like rock

Second blot—Looks like two animals Looks like entrance to a cave

Sixth blot—Looks like a bird on top of mountain

Responses of Case 51.

First blot—A crawfish—here's his mouth A bush A couple of rabbits Cat's tail An old fashioned lady. Bear's ear Pigeon flapping his wings A bat A witch A man's long nose and mouth Airplane tail Mountain side. Reindeer horns on a young one. Young butterfly A dog opening its mouth Dome of the Arena A liberty bell A lady. A man's nose A rabbit head sticking out

Second blot —A poodle dog A butterfly Two rabbits A thumb Two rabbits kissing each other. Center is a top you spin—or a lantern Two dogs walking together Those people with big lips A baby pigeon just born A little snail A puppy trying to stand up A fancy bridge like in China Crater of a volcano Cat all puffed up and scared A heart Tunnel Man with a crooked nose A rooster Chicken starting to cluck A man When a volcano shoots out A sunset A dirigible. A rabbit on the inside A duck

Sixth blot—An insect that flies on water A bear skin, open and on the floor A human's legs A bomb Part of an airplane A cat Someone's head Someone's hands A gorilla. A little dog's mouth A butterfly A fox skin Cat's whiskers A heart A small young butterfly A bed post. A spool A sword A heart. A crawfish A church steeple. A fountain A barrel A baby cradle. A flower pot A boat A mountain and valley A god of olden days Grass

Responses of Case 100

First blot—A cloud

Second blot—Two bears Two rabbits

Sixth blot—Part of a cloud

4. *Summary.*

a Of procedure Talkativeness in 50 stuttering children and a well equated control group of 50 children was measured by the number of words used in responding to the ten ink blots of the Rorschach personality test The nature of talkativeness in the two groups of children was investigated by analyzing differences in expressiveness on some Rorschach items, correlating talkativeness with these items and also correlating it with certain developmental, economic, and educational factors.

b. Of findings.

1) *Differences in amount and rate of talkativeness*

a) Stuttering children are 38 8% more talkative on the Rorschach test than are the children of the control group

b) The median number of words used by stuttering children is 200, the median used by children from the control group is 135.

c) The percentage of stuttering children who equal or exceed the median number of words given by the control group is 82.80.

d) The difference in time taken by the two groups of children to respond on all ink blots is very small and statistically insignificant.

e) If the number of words used in the total time taken is considered as an index of rate of talkativeness the mean rate for stuttering children is 51.08% greater than it is for the control group.

2) *Differences in expressiveness.*

a) Stuttering children name 56 63% more whole responses—many of which are vague perceptual wholes; give 14.47% more total responses—the largest difference by far is in greater percentage of non-content responses given by them; give 25.64% more movement responses, the Rorschach index of interiority, indicative of a trend to fantasy life as well as creativity, give 12 41% more color responses, the index of exteriority, give 23.42% more chiaroscuro responses indicative of absorption in the far away or disposition to depression. The control group surpasses the stuttering group by 14 49% on the Rorschach index of adaptable affectivity and 19 16% on clearness of perception or voluntary control of intellectual functioning

b) Regardless of the positive or negative direction of the relationship, talkativeness correlates higher with Rorschach factors in the children from the control group In all but one factor, F+, the correlation is larger positively. In the one factor which correlates negatively the correlation is more negative for the control group. A more detailed report of these correlations and suggested explanations are given in the body of the paper.

3) *Differences in nature of talkativeness*

a) Chronological age correlates —.10±.10 with the talkativeness of stuttering children and .25± 09 with the talkativeness of the control group The increase in restrictiveness of inner life (*koartieren*) which one finds with increased time span from onset of stuttering suggests that the differences in correlation are due to the increase in sensitivities and uncertainties which one finds with increased time span of speech disorder.

b) Mental age correlates with the talkativeness of stuttering children —.14± 10 and with the talkativeness of the control group 07± 09 The smaller difference on MA as compared with CA is merely evidence of the fact that the former is not as affected by time span from onset.

c) Occupational status correlates negatively with talkativeness in both groups of children The correlations for the stuttering and control groups respectively are— 17±.10 and —.31±.10.

d) Grade status correlates 05± 09 with talkativeness in the stuttering group and 42± 078 in the control group The difference in correlations indicates that the talkativeness of stuttering children is more influenced by personality factors.

e) Content responses (R) and talkativeness correlate .24± 08 in the children of the stuttering group and .82±.03 in children from the control group. This is the effect of the significantly larger amount of defense reactions, compensatory reactions, and other uses of words to cover up ignorance or lack of responsiveness which stuttering children practiced.

f) Illustrative samplings of the nature of differences described are given in the paper.

General Conclusions

Both in nature as well as extent of talkativeness in response to the ink blots of the Rorschach test stuttering children differ markedly from non-stuttering children. Considered as a group stuttering children talk significantly more than do non-stutterers The reasons for this larger amount of talkativeness in stuttering children are discernible in the differentiating characteristics in the nature of their verbal responses In this study this is indicated by differences in the specific forms of expressiveness evaluated by Rorschach's scheme of psychodiagnostics as modified by later investigators. The differences in the specific forms of expressiveness investigated may be expressed in general terms as follows: The responses of the stuttering children are characterized by greater productivity, the use of a larger number of qualifying phrases, of more non-content responses, more whole responses vaguely perceived, more introversiveness as well as extratensiveness On the other hand, it is more characteristic of the non-stuttering children to give more direct responses, more sharply perceived forms, more responses indicative of effective adaptability. Another important finding is that continued stuttering results in *koartieren*, a restriction of the individual's inner life[10]

Such are the findings. On the basis of them some Adlerians might be tempted to suggest that they all clearly indicate that the basic explanatory principle herein entailed is one found in other personality disturbances, namely, the psychology of compensation. More specifically their argument might easily enough take this form. Stuttering children experience more feelings of insecurity or uncertainty in situations calling for verbal responses. To cover up feelings of sensitivity and inadequacy they compensate. In this instance overcompensation is manifested in overexpressiveness—a sort of expressive neurosis. Specifically this is indicated particularly by the larger amount of talkativeness; the larger amount of both introversive and extratensive forms of expressiveness as well as other specific differentiating characteristics reported The fact that continued stuttering results in increased *koartieren*—restriction of inner life, indicated by guarded and inhibitory responses which kill off expressiveness—Adlerians can easily explain by describing the overexpressive stage as one of diffused energy output characterized by the presence of many defense reactions and the *koartieren* stage as one of restricted output of energy manifested in the form of a compulsion neurosis.

Behaviorists and scientific psychologists who slant in the direction of behaviorism without the label or allegiance to Watson, particularly students of Thorndike, might explain the findings in some such manner as this. Confronted by situations, adaptation to which call for adequate verbal patterns with which they are not equipped, stuttering children fall back on "substitute reactions" A fumbling process, that is, ensues. And in individuals whose difficulties are with speech this means verbal trial and error, hence the greater talkativeness. *Koartieren* following continued stuttering might, accordingly, be explained as the result of the elimination of those reactions or trials which resulted in failure, or else were perceived as such.

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[10] Treated more in detail in (10) and (11)

Arguments for other mechanisms and processes being the underlying principles which explain the findings reported in this study might easily be made. The present writer, however, sees no need for any all-explanatory principle Compensatory forms of expression are found in the responses of stuttering children. Verbal trial and error certainly is a characteristic which often distinguishes the stuttering child. But the acceptance of either one of the foregoing explanations or any other single explanation for differences found will, at the present time, tend towards the neglect of an adequate consideration of the actual differences found. The differences found, it should be remembered, can be expressed as measurable forms of reality Furthermore, not all are on the descriptive level or in need of theoretical interpretation. Many are practically as interpretive as ways of explaining which have longer traditions

In the light of the foregoing considerations it follows that the need in this field is not for armchair explanations but for *thoroughgoing psycho-social studies of the personality growth of stutterers This implies an investigation of personality before as well as after stuttering And such a "before and after" study in turn implies a study of all children who in some way represent a well defined sampling of the population which can be followed up* Some of the characteristics of such a study which appear to be essential are:

1. Approach should be comprehensive—should include contributions of psychiatry, psychology, sociology as well as of speech experts

2. Approach should be integrated—should not be directed by one sold on a single-explanatory principle but an eclectic with a sense of proportion who can make intelligent use of all relevant contributions considered from the point of view of method, results, and interpretations in terms of practical as well as theoretical consequences

3 Personality measurements made should be adequate from the point of view of revealing insights as well as statistical reliability

4 Life histories taken should contain all relevant information with emphasis on motivational factors which can be perceived in terms of situational factors (natural history of areas, etc.) as well as in the light of a knowledge of the genetic course of events

5 The personality pictures obtained before the onset of stuttering should be as complete as those obtained during and after.

In the opinion of the writer the foregoing list of characteristics represents minimum essentials for obtaining a comprehensive picture of the genesis and development of stuttering. Only through studies so planned can we hope to acquire enough understanding of the cause and effect relationships involved in the development and correction of stuttering personalities to make possible the elimination of the many contradictory all-explanatory formulas which are responsible for the present confusion in the field. Until such studies are made the possibility remains of explaining every aspect of the problem in terms of the one level of description a particular investigator or practitioner chooses to emphasize

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LA LOQUACITÉ CHEZ LES ENFANTS BÈGUES ET NON BÈGUES

(*Résumé*)

La nature et la quantité de la loquacité chez les enfants bègues et les enfants normaux sont, dans cette étude, étudiées par une analyse des différences dans les réponses de 50 enfants bègues et d'un groupe de contrôle de 50 enfants aux dix taches d'encre qui composent le test Rorschach La quantité de la loquacité est mesurée en termes des mots employés en réponse à toutes les dix taches d'encre, et la vitesse en termes du temps mis à répondre La nature de la loquacité a été etudiée par une analyse des différences dans les formes de la force d'expression comme indiquées par le test Rorschach et les corrélations de la loquacité avec des facteurs Rorschach choisis et de certains facteurs psychologiques, sociaux, et éducationnels

Les résultats explicatifs sont Les enfants bègues sont plus loquaces de 38,8 pour cent que les enfants du group de contrôle (Le pourcentage des enfants bègues qui égalent ou dépassent le nombre moyen de mots employés par le groupe de contrôle est de 82,80) La différence du temps mis n'est pas signifiante La loquacité donne une corrélation plus élevée avec tous les facteurs Rorschach étudiés chez les enfants non bègues que chez les bègues. L'âge chronologique et l'état scolaire donnent une corrélation plus élevée avec la loquacité chez le groupe de contrôle, et il paraît que la cause se trouve dans l'augmentation des sensibilités et des incertitudes (koartieren) laquelle on trouve chez les bègues avec une durée augmentée du temps apres le commencement du dérangement Les différences sur l'âge mental et l'état de l'occupation sont moins marquées et moins signifiantes ques les différences sur l'âge chronologique On inclut ici une discussion des interprétations possibles des résultats et des suggestions pour une étude plus étendue

MELTZER

GESPRACHIGKEIT BEI STOTTERNDEN UND NICHTSTOTTERNDEN KINDERN

(Referat)

Die Natur und der Umfang der Gesprachigkeit bei stotternden und normalen Kindern werden in dieser Untersuchung durch eine Analyse der Unterschiede in den Antworten von 50 stotternden Kindern und einer Kontrollgruppe von 50 Kindern auf die zehn Kleckse, untersucht die den Rorschach-Test ausmachen. Der Umfang der Gesprachigkeit wird auf Grund der in den Antworten auf die Kleckse gebrauchten Worter gemessen, und die Schnelligkeit auf Grund der verbrachten Zeit Die Natur der Gesprachigkeit wurde durch eine Analyse der Unterschiede in den Formen der Ausdrücklichkeit untersucht, die durch den Rorschachschen

Test erfolgte, und durch Korrelationen der Gesprachigkeit mit ausgewahlten Rorschach-Faktoren und gewissen psychologischen, sozialen und padagogischen Faktoren.

Erlauternde Befunde sind: Stotternde Kinder sind 38,8 Prozent gesprachiger als die Kinder der Kontrollgruppe. (Der Prozentsatz der stotternden Kinder, die der Durchschnittszahl der von der Kontrollgruppe gebrauchten Worter gleich oder uberlegen sind, ist 82,8) Der Unterschied der Zeit ist nicht bedeutsam Die Gesprachigkeit korreliert hoher mit allen Rorschachschen Faktoren bei nichtstotternden Kindern als bei den Stotterern. Chronologisches Alter und die Erziehungsstufe korrelieren hoher mit Gesprachigkeit in der Kontrollgruppe, die Ursache hiervon ist wahrscheinlich die Zunahme der Empfindlichkeiten und Ungewissheiten (koartieren), die bei Stotterern mit langstehender Storung gefunden werden Unterschiede im geistigen Alter und dem wirtschaftlichen Stand sind weniger bemerkenswert und bedeutsam als Unterschiede im chronologischen Alter Eine Besprechung der moglichen Deutungen der Befunde und Vorschlage zum weiteren Studium werden beigefugt

MELTZER

MEASUREMENTS OF ASSOCIATIVE LEARNING IN MENTALLY DEFECTIVE CASES OF READING DISABILITY: EVIDENCE CONCERNING THE INCIDENCE OF "WORD-BLINDNESS"*[1]

From the Wayne County Training School

RICHARD SEARS

The purpose of the present study is to investigate the relations of the abilities measured by Gates's associative learning tests to severe reading disability in a group of higher grade mental defectives. Evidence is presented concerning the incidence of "word-blindness" (in the sense of a special disability due to a specific organic brain defect) in this group The data were collected in the course of clinical practice

I. MATERIALS AND METHODS

Selection of Subjects Twenty-three subjects whose mental and educational status is summarized in Table 1 were used in the present investigation

Every member of this group was retarded approximately two years or more in reading as compared with MA grade-expectancy, and nearly all were at least a year further retarded in reading than in arithmetic computation. All the cases had been in school at least since the age of seven or eight, and most of them had been for some time in special classes for mental defectives.

Cases suffering from severe uncorrected defects of peripheral vision, of hearing, of speech, or from other severe sensory or motor handicaps which might complicate learning to read are not included in the group.

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*Recommended by Thorleif G Hegge, accepted for publication by Carl Murchison of the Editorial Board, and received in the Editorial Office, September 21, 1934

[1] From the Wayne County Training School, Northville, Michigan; Robert H. Haskell, M.D, Medical Superintendent *Studies in Educational Disabilities and Mental Deficiency,* directed by Thorleif G Hegge, Ph D., Scientific Director

TABLE 1

MENTAL AND EDUCATIONAL STATUS OF THE READING DISABILITY GROUP (23 cases)*

Item	Mean	S.D.	Range
Stanford-Binet IQ	72.1	7.6	56-84
Chronological Age	14.2	2.2	10.9-19.8
Mental Age	10.0	1.1	8.4-12.4
MA grade equivalent (Monroe)**	5.0	1.1	3.4-7.4
MA grade equivalent (Gates)†	4.2	1.0	2.9-6.4
Average reading grade (Monroe's Battery of Tests)‡	1.8	6	1.0-3.1
Arithmetic computation grade (Stanford Achievement Test)	3.8	7	2.6-4.9

*In correlating the Stanford-Binet and Stanford Achievement data used in this table, interpolated or extrapolated scores, corrected to the date when the Gates Associative Learning Tests were given, have been used wherever this facilitates accurate comparison. However, since each case was given Stanford-Binet tests at yearly intervals, and Stanford Achievement tests at half-yearly intervals, the estimated scores are invariably quite close to the actual test scores. In compiling the reading grade scores, the actual scores obtained when the cases were first examined for reading disability were used. These reading examinations were all given either shortly before or shortly after Gates's associative learning tests.

**The age-grade equivalent used by Monroe (7, pp. 190-191) in estimating degree of reading disability, and employed in the estimates of MA—reading grade discrepancy stated on p. 391 of this paper, is based on the assumption that the normal child, unless hindered by unfavorable circumstances, can start school at the age of 6.0 and progress at the rate of one grade per school year. There is adequate evidence for the further assumption that the mentally defective child not handicapped by special disability can generally attain approximately the same grade rating, measured by achievement tests, as the normal child of equivalent mental age. Merrill (6) as a result of an elaborate study found this to be the case. This has also been found to be the case at the Wayne County Training School.

†Gates's age-grade equivalents differ from those of Monroe in being based on the average ages actually found among normal pupils at the various grade levels in representative large school systems (Gates, 3, pp. 357-358). These are the age-grade equivalents used in the associative learning test standards reported in Table 2. As far as the interpretation of the results of the present study is concerned it makes no appreciable difference whether Monroe's or Gates' age-grade equivalents are used.

‡The "average reading grades" are based on a modified form of the battery of reading tests described by Monroe (7, pp. 183-188). Five different reading tests were used: the Iota Word Test, Monroe's Word Discrimination Test, Gray's Oral Reading Test and two silent reading "comprehension" tests. For the cases reported here these two tests were usually Gates's Silent Reading, Types 2 and 3.

Within the limits indicated it is felt that the present group is representative of severe reading disability cases of similar IQ and MA range.

The Associative Learning Tests. The subjects were given a battery of six associative learning tests devised by Gates for the investigation of reading disability.

This battery consists of three tests of visual-visual and three tests of visual-auditory association approximating "the actual forms of learning, required in the beginning stages of mastering words," but employing artificial letter-like and word-like symbols [2]

A more detailed description of the tests follows, given partly in Gates's own words

> The three tests of visual-visual association represent the learning of three types of figures in connection with pictures which give the "meaning" of the characters Each test consists of ten cards each with a "new word" (i e symbol) beneath a picture The pupil is given presentation and test lessons In the test lessons the pupil is shown the symbol alone and asked to name the thing which had been presented with it
>
> Test A1 consists of very simple figures associated with pictures of common objects
>
> Test A2 is the same as Test A1 except that it includes somewhat more unusual and complex visual symbols
>
> Test A3 is the same as the others except that it contains symbols that are more complex, more unusual and more like words in a new language

The three visual-auditory association tests (B1, B2, B3) are, respectively, approximately equivalent to the three visual-visual tests, except that the symbols are associated with sounds instead of with pictures In test B1 the symbols are associated with sounds such as long *i*, *gee*, *kay*, etc In tests B2 and B3 the symbols are associated with common one-syllable spoken words such as *man*, *saw*, *top*, etc [3]

The tests are presented by Gates, along with measurements of various factors related to reading disability, "not as instruments fully refined and understood, but as tests in the making, in the hope that other students may, by using them, facilitate the process of change and improvement."

Previous Studies The test results of the present investigation are compared with standards worked out by Gates for normal readers of normal intelligence These standards give grade scores in quarters of a grade (with equivalent age scores) from grade 1.5 to grade 6.75 inclusive. A steady improvement in raw scores, though by small increments, is found with all the tests at least through the fourth grade[4]

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[2] These tests are reported in Gates (3, pp 267-273, 343-358, 404-422).

[3] See Gates (3, pp 267-269)

Studies of the achievements of normal and retarded readers in associative learning tests have been reported by Gates himself, by Monroe (7) and by Fildes (2).

For reading disability cases Gates has not published data on associative learning comparable with his standards for normal readers He does, however, give rough estimates, partly subjective, of the percentage of mild and serious deficiencies in associative learning found among some 400 reading disability cases of normal intelligence[5]

Monroe (5, pp 94-95) and Fildes (2) have reported results of visual-auditory learning tests somewhat similar to those of Gates.

In comparing 32 reading disability cases of normal intelligence with a control group Monroe found a significant difference in favor of the normal readers. Fildes, on the other hand, found that a group of 26 reading disability cases, partly of normal and partly of sub-normal intelligence, did as well as a control group of normal readers.

These two experiments are difficult to interpret and are hardly comparable.

Both the visual and the auditory symbols of Monroe's test were meaningless. As Monroe herself has implied, the differences between her two groups may have been largely in auditory discrimination rather than in associative learning ability or visual perception. Fildes' test required the association of visual forms similar to stenographic signs with common spoken words This test is more similar to Gates's than is Monroe's. Fildes' choice of subjects and other aspects of her experiment have been criticized by Dearborn (1).

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[4] See Gates (3, pp 404-412) There are ten associations to be learned in each test. The raw score is the number of associations correctly learned.

[5] See Gates (3, pp. 343-353). Gates makes a distinction between acquired and organic defects in these functions Serious "defects in techniques of associative learning of all types applied" are estimated as occurring in 6 per cent, and serious organic defects in associative learning are estimated as occurring in 2 or 3 per cent of this total group

It must, of course, be assumed that associative learning abilities vary with an uncertain degree of specificity, along with the type of material to be learned. A complete study of the various associative learning abilities possibly important for reading would no doubt require a wide variety of tests While Gates's six tests may not adequately sample this whole field, they do provide a much wider sampling than the associative learning tests of Monroe or Fildes

II. Presentation of Data

Group Results. Table 2 gives the scores made on Gates's associative learning tests by the reading disability group described in Table 1.

TABLE 2

Group Scores in Associative Learning

Test	No of cases	Raw scores Mean	S.D	Grade score Means	Age score Means
Test A1 Visual-visual	23	8 7	1 4	Above 6.75	Above 12 85
Test A2 Visual-visual	22	8 2	1 7	Above 6.75	Above 12 85
Test A3. Visual-visual	23	6.1	2 7	4.50	10 40
Test B1. Visual-auditory	*23*	*7 0*	*2 1*	*3 75*	*9.45*
Test B2· Visual-auditory	22	9.4	9	6 00	12 00
Test B3· Visual-auditory	23	7 3	2 2	4 75	10.65

It will be observed that in every test the average age score attained by the cases is close to or above their average Stanford-Binet mental age.

Since the average scores are consistently high on all the tests, and since the variability of individual scores on most of the tests is not great, the results are probably quite reliable in spite of the small number of cases

Analysis of Individual Scores An analysis of individual scores follows.

Table 3 shows the number of cases scoring at grade 4 25 or better

TABLE 3

Number of Cases Scoring at Grade 4.25 or Better on One or More Tests

On 1 test or more	*On 2 tests or more*	*On 3 tests or more*	*On 4 tests or more*	*On 5 tests or more*	*On all 6 tests*
22	22	20	15	11	4

on one or more of the six tests. Grade 4.25 corresponds to an age score of 10.0 which is equivalent to the average mental age of the present group. Assuming its reliability, a score as high as this may be considered to indicate that the subject has no special deficiency in the ability tested sufficient to handicap him in learning to read.

It will be observed that only one subject was unable to score at grade 4.25 or above on two or more tests, and that only three subjects were unable to meet this standard on three or more tests.

In Table 4 is presented the number of cases scoring at grade 4.25 or better, and at grade 2.5 or better in each test. Grade 2.5 is somewhat arbitrarily chosen as a means of indicating the relative proportions of low scores on the various tests. A score as high as grade 2.5 may be considered to indicate that the subject has no marked special deficiency in the function tested. The normal reader at grade 2.5 has, of course, attained a considerable degree of proficiency in word reading. In the associative learning test norms a grade score of 4.25 represents only a small increment in raw score as compared with grade 2.5.

TABLE 4

NUMBER OF CASES SCORING AT GRADE 4.25 OR BETTER AND AT GRADE 2.5 OR BETTER ON EACH TEST

	Test A1	Test A2	Test A3	Test B1	Test B2	Test B3
No. cases scoring at Grade 4.25 or above	19	14	13	15	18	17
No. cases scoring at Grade 2.5 or above	20	20	16	18	21	19

Without supporting evidence from other tests an individual score on a single one of the associative learning tests must be considered as of rather doubtful reliability. However, such supporting evidence is generally present in the case of high scores. In any case, other things being equal, a high score may no doubt be considered as a more reliable measure—at least of capacity—than a low score. As will be seen, very few subjects showed any tendency consistently to make low scores on any particular type of test. Low scores probably were due to some factor of unreliability in the measurements rather than to any lack of capacity in the function tested

The tendency for low grade scores to occur seems to be least for tests A1 and B2, slightly greater for tests A2, B1, and B3, and greatest for test A3

Possibly the visual-visual series was a little harder for the group as a whole than the visual-auditory series, but the difference, if any, is too slight and inconsistent to be clear [6] Only one subject showed any marked tendency to have more difficulty with one of these series than the other. Twenty-one cases made a grade score of 4 25 or better on at least one test in both the visual-visual and the visual-auditory series.

Increasing complexity of the visual word-like symbols appears to result in some increase in the number of low grade scores in the visual-visual series, but this tendency is not clearly observable in the visual-auditory series. In all, 19 cases were able to make a grade score of 4 25 or better in one or the other of the two tests (A3 and B3) utilizing the most complex type of visual word-like symbols.

A more elaborate testing program with better controls[7] might disclose some significant relationship between reading disability and increasing complexity of visual word-like symbols in associative learning tests, but within the limits of the Gates tests any such relationship would probably turn out not to be marked.

Considering the data as a whole, it seems that not more than five of the 23 cases can have had significant special defects—at least at the time when the tests were given—in any of the types of ability measured by Gates's associative learning tests The evidence for this is that the remainder of the cases were all able to make scores of grade 4.25 or better on at least one visual-visual test, at least one visual-auditory test, and at least one of the tests, A3 and B3, which utilize the most complex visual word-like symbols

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[6] The meaning of poor scores on visual-auditory test B1 is obscured by the fact that in this test the auditory symbols are letter names instead of common spoken words as in the other two tests. For some subjects these letter names may present greater difficulties (as compared with normal readers of normal intelligence) in auditory discrimination or in association than would words of more concrete meaning

[7] For our reading disability group this would involve the use of a control group of mental defectives who were normal readers for mental age

The Problem of "Word-Blindness." The present findings require a comment on "word-blindness." This term has been widely used to describe cases of severe special reading disability in which there is inability, partial or complete, to get meaning from common visual word patterns, though there is no serious impairment of vision Word-blindness has sometimes been used as a descriptive term without regard to theories of causation Many ophthalmologists and neurologists, however, have considered this condition to be due to an organic defect in some specific brain area In the opinion of Hinshelwood, who has written the classical work on the subject from the ophthalmological point of view, word-blindness is due to a brain defect localized in the angular and supra-marginal gyri of one or both parietal lobes, or in the connecting fibers between this area and "the primary visual (perceptive) centres" in the occipital lobes. In Hinshelwood's opinion this defect may be either congenital or acquired.[8]

For the sake of convenience the term "word-blindness" will be used during the rest of this discussion in the sense of a severe special disability caused by a specific organic brain defect (not necessarily *the* specific defect postulated by Hinshelwood).

Since it is only in very rare cases of reading disability that neurological evidence sufficient to prove or disprove the existence of "word-blindness" is available, experimental evidence concerning the incidence of this condition has been limited to the results of investigations with associative learning tests, such as those of Gates, which require the learning of artificial word-like symbols While low scores on these tests cannot be regarded as proof of the existence of word-blindness in a case, high scores, if reliable, may be accepted as fairly safe indicators that the case is not "word-blind" to any significant degree It seems out of the question that a case who is suffering from word-blindness could, without any special training, learn rapidly and efficiently to "read" artificial word-like symbols which are totally unfamiliar to him

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[8] There is adequate neurological evidence of the existence of lesions, such as those postulated by Hinshelwood, in cases of acquired word-blindness. See Hinshelwood (5, pp 33-39), and Pieron (8, pp. 153-156). Such evidence is lacking, however, for cases of "congenital word-blindness," or for cases who have not at some time been able to read See discussion by Burt, quoted in Gates (3, p. 272). There is a good summary of the literature on word-blindness in Tinker (9, pp 294-295).

On the other hand, mere demonstration of the ability of a case to have slowly learned to read a few words in the classroom, or even demonstration of ability to improve markedly in reading under special methods of remedial training cannot be regarded as adequate proof that the case was not to some significant degree word-blind[9] Hinshelwood and others believe that marked improvement in reading in many word-blind cases is possible, since if the brain defect involves merely the dominant hemisphere, the case may be able to learn by utilizing the other hemisphere

Nevertheless, consistently rapid improvement of cases of severe reading disability during remedial training may, no doubt, be considered as helping to confirm the evidence of high scores on associative learning tests that the cases were not word-blind.

All of the 23 cases were poor word readers when first tested for special reading disability However, all but two cases were able either during individual remedial training or special help in the classroom to learn to read common one-syllable words adequately as wholes. By "as wholes" is meant ability to read the words, roughly speaking, at a glance without spelling, "sounding," or other piecemeal methods of attack such as could be detected by careful individual clinical observation[10]

With the two exceptions mentioned, improvement during the special training was rapid in nearly all cases, especially during the earlier stages of the training.[11]

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[9] There is another angle of the question which deserves to be mentioned here. One occasionally finds cases such as those discussed on page 400, who even after intensive and long continued individual special training prove unable to learn to read words as wholes In such cases the results of the special training may be considered as good presumptive evidence—though not as proof—that the case *is* word-blind.

[10] Ability to read words "as wholes" was judged by observations made during individual oral tests (the Iota Word Test and Gray's Oral Reading Paragraphs), supplemented in most cases by reports on the individual reading lessons

[11] Eighteen of the 23 cases were given intensive individual remedial training outside the classroom during which half-hour lessons were given four or five times a week During the first four months of training the average reading grade of this group as measured by a battery of standardized tests advanced from 1.8 to 2 9 Only one case (*Hf*) made less than half a grade's progress during this time With further individual remedial training most cases proved able eventually to raise their reading grades approximately to the level of their mental-age grade-equivalents Reading progress for the group as a whole was similar to that reported of a group, composed in part of the same cases, by Hegge (4)

The two cases who "failed" in remedial training were among the four who were unable to make a fourth grade score on either of Gates's tests A3 and B3. One of these cases, *Co,* was able to make maximum scores on several of the perceptually easier Gates tests, both visual and auditory He also made considerable progress in reading by means of phonics, but seemed unable even after intensive and long continued remedial training to learn to read any but very simple word patterns without recourse to preliminary "sounding" of the separate syllables

The remaining case, *Hf,* was the only subject to score below grade 2.5 on all six of the Gates tests. He made some progress in learning to read by means of spelling and sounding of individual letters and syllables (he seemed to have adequate perception of these units), but proved to be the slowest and most limited learner in the group. In tests, even after a year and one-half of intensive individual remedial training, he was never able to score appreciably above middle second grade, which seemed to represent the limit of his trainability Even at the first and second grade level he was able to read only a very few of the simplest word patterns without recourse to laborious spelling or "sounding" of the parts.[12] The Binet mental age warranted an expectation of low fourth grade reading ability

The reactions of these two cases to remedial training, while not proving that they are word-blind, at least warrant a strong suspicion that they may be suffering from this condition. In neither case did it seem that the learning difficulty could be attributed to poor interest or effort, or to emotional blocking.

III. CONCLUSIONS

All of the writer's group of 23 mentally defective cases were very poor word readers when first tested for special reading disability, as reported in Table 1 As far as their reading performance was concerned they might legitimately have been termed word-blind

The evidence which has been presented seems sufficient to demonstrate that the incidence of word-blindness, in the sense of a severe special disability caused by a specific organic brain defect, was nevertheless extremely slight in this group. In at least 19 of the 23 cases there is evidence sufficient to exclude word-blindness, in the sense used here, as a significant cause of the reading disability.

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[12] *Hf's* visual fields were examined by an ophthalmologist Considerable constriction of both fields was found, of the interpretation of which the ophthalmologist was uncertain, but there was no evidence of hemianopsia. *Co's* visual fields were not examined.

Regardless of the question of underlying brain mechanisms, the results of the present investigation suggest that—at least in groups similar to ours—deficiencies in the associative learning abilities measured by the Gates tests are seldom significant causes of reading disability. In the few cases where the tests appear to indicate such deficiencies it seems that the difficulties may often be due to rather readily remediable bad habits of perception of the more complex visual word-like forms.

It is a reasonable inference that among reading disability cases of higher general mentality or less degree of specific disability than the cases of the present group, deficiencies in the functions measured by the Gates tests are even less frequent.[18]

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[18] The results reported by Gates himself (see p 394 this paper) are not directly comparable with those reported here, but are consistent with the above statement.

LES MESURES DE L'APPRENTISSAGE PAR ASSOCIATION DANS LES CAS D'INCAPACITÉ À LIRE CHEZ DES FAIBLES D'ESPRIT

(Résumé)

Les vingt-trois sujets de cette investigation ont été tous des cas de faibles d'esprit montrant une grande incapacité spéciale de lire, trouvant de la difficulté dans la lecture des mots usuels Le Q I moyen Stanford-Binet a été de 72,1; l'âge mental moyen, de 10,0.

On a fait subir à ces sujets une batterie de six tests d'apprentissage par association, formulés par Gates, lesquels utilisent des symboles "artificiels" qui ressemblent aux lettres et aux mots dans des situations pareilles à celles rencontrées dans les premières etapes de l'apprentissage de la lecture

On a constaté que dans chacun de ces six tests le résultat moyen du groupe a été assez près ou au-dessus de ce à quoi l'on s'attend pour l'âge mental Les résultats de divers individus dans le même test, et ceux du même individu dans divers tests se sont montrés constamment élevés Il *n'y a pas eu de différence appréciable dans l'incidence des résultats des* âges moins avances ("classe") dans l'association visuelle-visuelle comparée avec l'association visuelle-auditive Il y a eu une petite tendance assez inconséquente vers une plus grande fréquence des résultats des âges moins *avancés (ou de "classe") dans les tests qui utilisent les formes visuelles* plus complexes qui resemblent aux mots

On conclut que l'évidence rejette "l'aveuglement pour les mots," dans le sens d'une incapacité spéciale causée par un défaut organique spécifique du cerveau, comme explication de la difficulté de la lecture dans au moins dix-neuf des vingt-trois cas.

Sears

DIE MESSUNG DES ASSOZIATIONSLERNENS BEI GEISTESSCHWACHEN FALLEN VON LESEUNFAHIGKEIT

(Referat)

Die dreiundzwanzig Vpn in dieser Untersuchung waren alle geistesschwache Falle von einer besonderen schweren Leseunfahigkeit, die Schwierigkeiten beim Lesen gewohnlicher Worte hatten Der Durchschnittsintelligenzquotient beim Stanford-Binet war 72,1, das durchschnittliche Geistesalter war 10,0

Diesen Vpn wurden eine Batterie von sechs von Gates aufgestellten Assoziationstests gegeben, welche "kunstliche" buchstabenartige und wortartige Symbole in Situationen verwenden, die denen ahnlich sind, die in den fruhen Stadien des Lesenlernens angetroffen werden

Es fand sich, dass in jedem der sechs Tests der Durchschnittswert der Gruppe der Erwartung nahe war oder uber die Erwartung fur das Geistesalter hinausging Die Werte für die verschiedenen Vpn bei demselben Test und für dasselbe Individuum in verschiedenen Tests waren durchaus hoch Es gab keinen bemerkbaren Unterschied in der Haufigkeit der niedrigen Alterswerte in der Gesicht-Gesicht- im Vergleich zur Gesicht-Gehorassoziation. Es gab eine geringe, ziemlich widersprechende Tendenz zur grosseren Haufigkeit der niedrigen Alterswerte bei Tests, die die verwickelteren wortartigen Gesichtsgebilde verwenden

Der Schluss wird gezogen, dass die Evidenz die "Wortblindheit" im Sinne der speziellen Unfahigkeit, die durch ein spezifisches organisches Hirngebrechen verursacht wurde, als Erklarung der Leseschwierigkeit in wenigstens neunzehn der dreiundzwanzig Falle ausschliesst

Sears

A STUDY OF THE CONSISTENCY OF DOMINANT AND SUBMISSIVE BEHAVIOR IN ADOLESCENT BOYS*[1]

From the Department of Sociology, Harvard University

EDGAR A SCHULER

I. INTRODUCTION

There is much disagreement at the present time among psychologists and sociologists with regard to the question of consistency of individual behavior Numerous investigations have been made in the hope of showing clearly either that consistency of behavior prevails (thereby supporting the hypothesis of personality "traits") or that the type of situation in which the individual is placed determines the type of his behavior.

There are many hypothetical personality traits whose investigation might throw light on this problem, but dominance and submission are certainly among the most important To the sociologists and social psychologists who are interested in social gradients, in the bases of social control and social organization, and in the various related social processes, a full understanding of "dominant" and "submissive" behavior is imperative The present study is an attempt to contribute to the knowledge of the nature and extent of consistency of behavior as revealed in these two socially significant types of behavior.

II. LITERATURE BEARING ON THE PROBLEM

Ascendance and submission as behavior or personality traits have been studied from many points of view Important contributions have come from investigations of the social relations among birds and

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*Accepted for publication by John E Anderson of the Editorial Board and received in the Editorial Office, August 13, 1934

[1] Since this paper is a condensation of a doctoral dissertation (16) it is impossible to repeat here all the acknowledgments there expressed The writer again, however, gratefully acknowledges his indebtedness to Professor G W. Allport in connection with this study, and his even greater *obligations to Professor P A Sorokin But the foregoing critics and advisors* are not at all responsible for the methodology here employed or for the conclusions reached

animals, of the phenomena of group leadership, prestige, suggestion and suggestibility, the "inferiority complex" of Adler, sibling position and intra-familial relationships, introversion and extraversion, and even certain types of anti-social behavior

The literature bearing more directly on the problem may be reviewed briefly. Much work has been done in the study of dominant and submissive behavior traits among infants and children of preschool age. On the basis of studies made by Buhler (5), Chevala-Janovskaya (6, 7), Parten (15), and others, it appears that children who are older, physically stronger, excited verbally more quickly and more persistently, and/or who have higher IQ's, tend to be leaders. Other psychologists (8, 19) report great difficulty in attempting radically to modify behavior tendencies of extremely aggressive nursery-school children.

Studies of children of school age are less numerous The results of an investigation of social attitudes by Monchina (12) have been summarized as follows:

> 1. A child responds with an aggressive reaction to a disapproved act on the part of a playfellow, but girls are less aggressive than boys.
>
> 2 The older the child, the less aggressive he is, but around the ages of 12 and 13 the growth of aggressiveness becomes marked

The study by Newcomb (14), although subject to various criticisms (16), should be mentioned here His conclusions, in general, are that inconsistency rather than consistency of behavior prevails, and that where the latter is thought to be found the subjective processes of the investigator may be responsible The findings and interpretations of the Character Education Inquiry include some very suggestive material on the importance of socio-economic background for consistency of behavior (10) In fact, it appears that the increase or decrease of consistency in honesty is intimately related to the social milieu, but whether "honesty" may validly be regarded as representative of personality traits, a basic question and still unanswered, detracts from the weight and relevance of the finding for our purposes.

Ascendance, submission, and leadership among college students have been studied experimentally by Moore and Gilliland (13), while Allport and Allport (1) have utilized the questionnaire method The well-known Ascendance-Submission test of G. W. Allport has been used by various investigators in analyzing the relationships of these traits with other factors (2, 3, 4, 11, 18). The references given merely hint at the extent to which dominance and submission (under various closely related names) have been investigated, and suggest their importance to the sociologist and social psychologist.

III. Selection of Subjects, Methods Used, and Data Derived

The subjects originally selected for this investigation included all boys in the Junior High School and Senior High School of R——, Massachusetts. However, incomplete data and selective elimination, as described later, materially reduced the number of subjects. The data for each individual included· (1) a rating by the teacher, (2) *ratings by the student himself; (3) ratings by one parent* or both parents, (4) experimental data secured by the investigator, (5) IQ's based on one or more tests, and (6) chronological age.

1 *Teachers' Ratings.* Each teacher in the Junior High School was provided with a list giving the names of the boys in the seventh, eighth, and ninth grades, and was asked to rate those with whom he or she was well *acquainted according to the following set of instructions*[2]

> Please read through this list of names of [eighth] grade boys Note all those who impress you as being *extremely dominant*, indicate each name selected by printing the letter "D" after it. Likewise, note all those who impress you as being *extremely submissive*, indicate these names by printing the letter "S" after them For purposes of comparison select as many *average* individuals as you have chosen in the other two groups together, *indicate these names by the letter* "A".
>
> Definitions
>
> The "dominant" boy is the one who attempts to control, influence, and direct the behavior of other individuals
>
> The "submissive" boy submits, obeys, and subordinates himself to the authority and leadership of other individuals
>
> The "average" boy is neither clearly dominant nor submissive

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[2] Each Senior High School teacher received a set of names of the sophomore, junior, and senior boys with similar instructions and definitions

These definitions are not sufficiently precise to guarantee the standards or situations by which the various teachers judged the boys to be always the same If each boy behaved similarly with regard to the traits in question in all school situations, if the definitions of these traits were interpreted in exactly the same way by all teachers, and if all teachers knew the boys well enough to rate each of them, we should expect the following results: no boy would be placed in more than one behavior type; many boys would not be placed in any category of typical behavior, and there would be no differences *between boys as to the number of teachers rating one as being of* one type, and another as being of another type.

The results actually obtained, however, were as follows· Only a third of the Junior and less than a fifth of the Senior High School boys were rated consistently, that is, as either D, A, or S exclusively. Among the older boys a fourth were rated at least once as D, A, *and* S When all individuals rated as being of two or more behavior types were taken together, the group comprised fully two-thirds of the younger, and four-fifths of the older boys. Thus, perfect consistency of behavior, or at least of rating, was far from being revealed When only those cases were considered in which at least three raters agreed as to the proper designation for a boy, much smaller groups were placed in each behavior type, but there was necessarily greater agreement among the raters

The number of teachers rating boys in the various grades, and the degree of agreement among the teachers making ratings, tended to increase with the length of time the boys had been in the school The average number of ratings per teacher for the seventh grade was 20.6, for the eighth, 21.0, for the ninth, 22.3, for the sophomores, 18.6, for the juniors, 22 3, for the seniors, 28 8 Since the minimum period any teacher had been employed in the schools was three years, the factor of annual teacher turnover was of no significance in evaluating these ratings

The teachers' ratings were used as a basis of selection for the boys hereafter designated as the "Selected Group" The plan was to select roughly equal numbers of boys (usually about ten) in each behavior type from each grade, using the agreement of from three to six teachers as the criterion. In Tables 1A and 1B, showing the cumulative frequency of boys rated as D, A, or S by teachers, the *italicized numerals indicate the number included in the Selected Group*

TABLE 1A

CUMULATIVE NUMBERS OF BOYS RATED BY THREE OR MORE TEACHERS AS D, A, OR S—JUNIOR HIGH SCHOOL*

Number of teachers agreeing	Seventh grade D	A	S	Eighth grade D	A	S	Ninth grade D	A	S	Totals
8							1		1	2
7	2			1			3		1	7
6	4	1		1	1	3	6	1	3	20
5	8	2	2	4	3	5	6	6	5	41
4	10	2	4	7	5	6	9	9	9	61
3	17	13	10	13	10	10	10	16	14	113

*Two boys rated as belonging in two behavior categories by three teachers (e g, D-3, A-3) are excluded from this table

TABLE 1B

CUMULATIVE NUMBERS OF BOYS RATED BY THREE OR MORE TEACHERS AS D, A, OR S—*SENIOR HIGH SCHOOL**

Number of teachers agreeing	Sophomores D	A	S	Juniors D	A	S	Seniors D	A	S	Totals
12							1			1
9				1						1
8				2	1					3
7				5	2		2	2	1	12
6	1			5	7	4	7	7	2	33
5	3	2	1	9	12	4	7	12	7	57
4	7	10	3	12	18	9	7	23	12	101
3	9	21	14	15	29	13	12	26	15	154

*Eleven boys, rated as belonging in two behavior categories by three or more teachers each (e g., D-3, A-3), are excluded from this table

from each behavior type in each class The total number selected was 191, of whom 61 were D, 66 were A, and 64 were S[8]

The findings derived from an analysis of the teachers' ratings may be summarized as follows·

a Using a single teacher's rating as a minimum criterion, 34 per cent of Junior High School and 18 per cent of Senior High School boys were rated exclusively as D, A, or S.

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[8] Although the desirability of determining the reliability of the individual teacher's ratings was recognized, the problem was not attacked This was because the main object of the present study was to determine the relationship between various measures of the same phenomena, of which teachers' ratings were only one measure, and not the final criterion

b Ten per cent of Junior High School and 26 per cent of Senior High School boys were rated at least one teacher each, D, A, *and* S.

c Sixty-one per cent of Junior High School and 82 per cent of Senior High School boys were rated as of more than one behavior type.

d. Agreement of teachers' ratings was greatest in the case of dominant boys.

e There was an increasing average number of ratings per teacher from class to class within each school.

f There was greater agreement of teachers in rating boys whom they had known longest, or boys who were oldest—the greatest consistency of rating being found among boys in the Senior class

2 *IQ and Age Data* Since the school system from which these subjects were drawn employed a psychologist on its staff, data were available from both intelligence and special abilities tests. If a student had taken more than one test, the average score was computed and used.[4]

The chronological ages of all boys were obtained from official school records and reduced to months as of Jan 1, 1933 The range of ages of the 232 Junior High School boys supplying self-ratings was from 125 to 202 months, with 162 5 as the average The 195 Senior High School boys ranged from 163 months to 252, averaging 197 7 The IQ of the Junior group ranged from 70 to 142, and averaged 107 6. The IQ of the Senior group (excluding the 25 boys for whom this material was not available) ranged from 77 to 159, and averaged 110 0.

3. *Parents' Ratings* The scale on which parents were to rate their sons was designed to present a variety of situations which are commonly encountered by adolescent boys, and to suggest five different modes of behavior that might occur in each situation The parents were then asked to indicate which response their son was most likely to exhibit Theoretically the situations chosen permitted a range of behavior varying from "dominant" to "submissive," and were so frequently encountered as to be applicable to boys of the ages studied regardless of economic class, recreational preferences,

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[4] The intelligence tests given varied from grade to grade and from year to year, the National, Dearborn, Otis, and Terman group tests being those most commonly used

etc The five possible reactions which were supplied were phrased as answers to a question, two of which indicated dominant tendencies, two submissive, and one average (that is, in case neither marked dominance nor submissiveness was discernible).

Of the twenty-two situations presented six dealt with relationships of parent and child, six with relationships between siblings, five with relationships between the subject and his associates, and five with miscellaneous experiences.[5] The answers for the first, third, fifth, etc., questions were presented in the sequence of most submissive, slightly submissive, average, slightly dominant, markedly dominant. This arrangement was reversed for the second, fourth, sixth, etc, situations Separate ratings were solicited from the father and mother

A sample "situation" follows·

> When you give your son and one of his brothers or sisters *something to do?*
> ( ) Almost always he waits for the other one to divide up the task—direct him
> ( ) Quite often he waits for directions from brother or sister
> ( ) Sometimes he "takes charge"—sometimes not (about equally often)
> ( ) Quite often he directs—rarely accepts his brother's or sister's orders
> ( ) Usually he "takes charge" of the situation—assigns or divides the work

Various circumstances reduced the number in the Selected Group from 191 to 185 The rating scale described above was sent to the parents of these 185 boys As was to be expected, parental cooperation was not perfect, but returns were received from 60 per cent of the cases. In order to determine whether any selective factors were operating between the group of parents who returned the ratings and the group who did not, the two groups of sons involved were compared on the following bases· age, IQ, socio-economic status, and teachers' ratings On the whole, apparently no important selective bias was present.

A total of 111 boys was rated by one or both parents In attempting to score and analyze the data in these ratings, the chief question kept in mind was this are the boys who are classed in one category on the basis of one of the criteria used also shown to fall in the same category on the basis of the other available criteria? Hence it was necessary first to establish, on the basis of all the parents' answers, what constituted dominant, submissive, and average behavior in each situation presented, then to determine how boys who were rated as D, A, or S by their teachers were rated by their parents

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[5] For convenience these groups of hypothetical situations will be referred to as "Question Groups" or Groups I, II, III, and IV, respectively

The method employed in evaluating the responses was a weighting system designed to give a heavy weight, or large score, to the rarely given ratings, and a proportionately smaller weight to the more frequently given ratings[6] This system of treating the data—which evaluated *one* father's, mother's, and son's ratings in terms of how *all* fathers, mothers, and sons, respectively, rated—constituted an attempt to bring out clearly the direction and degree of extremeness of the individual's behavior with reference to the several social norms involved This same method was used in the determination of self rating scores In each set of ratings the Junior and Senior High School groups were scored separately, however, because on certain questions considerable differences appeared in the distributions of responses

4 *Self-Ratings* The self-rating scale, by which the boys were to judge their own behavior, contained the same situations and possible answers as those of the parent-rating scale The questions were changed to read, "What do you do when. . . ?" instead of, "What does your son do when. . . ?" Eight of these situations were repeated in a generalized form: "What do most boys do in this situation?" These impersonal questions were included so the data would be available for comparison with certain responses in the experimentation

A few other items of information were secured These included, father's occupation; number, sex, and relative position of siblings (older, younger); and "parental condition" (that is, whether either parent were dead, whether a step-parent were in the home, etc.)

The teachers gave the forms to both the Junior and Senior High School pupils To aid in standardizing the procedure, each teacher was given an introductory statement to read to the class before handing out the scale Absentees were given the test during the following week.

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[6] For an exposition of the method used see reference (9)

The relation of the self-rating scores to a number of other factors was investigated (See Tables 2A, 2B, 2C, and 2D). Since the entire self-rating scale was composed of four groups of questions, each dealing with a distinct type of situation[7] it was decided to take the

TABLE 2A

COMPARISON BETWEEN YOUNGER AND OLDER GROUPS OF BOYS IN AVERAGE IQ AND IN AVERAGE SELF-RATING SCORES FOR THE FOUR GROUPS OF QUESTIONS

Age group	Number of boys	Average age (in mos)	Average self-rating score group I	group II	group III	group IV	Average IQ
		Junior High School boys					
Younger	59	143.5	39.5	37.2	40.2	41.5	115.4
Older	51	182.9	39.8	42.1	39.7	38.6	95.3
		Senior High School boys					
Younger	15	172	39.7	40.5	41.2	40.9	122.7
Older	26	223.1	40.8	42.7	41.5	39.5	101.5

TABLE 2B

COMPARISON BETWEEN LOW AND HIGH IQ GROUPS OF BOYS IN AVERAGE AGE AND IN AVERAGE SELF-RATING SCORES FOR THE FOUR GROUPS OF QUESTIONS

IQ group	Number of boys	Average IQ	Average self-rating score group I	group II	group III	group IV	Average age (in mos)
		Junior High School boys					
Low	25	84.0	36.9	36.6	36.3	39.3	179.8
High	47	127.2	40.3	42.1	39.7	40.3	152.8
		Senior High School boys					
Low	32	92.2	36.6	36.2	39.9	39.1	206.1
High	31	129.6	41.2	38.4	39.9	41.3	188.9

TABLE 2C

AVERAGE AGE, IQ, AND SELF-RATING SCORES OF GROUPS OF BOYS FROM FAMILIES IN UPPER AND LOWER SOCIO-ECONOMIC CLASSES

Socio-economic group	Number of boys	Average age (in mos)	Average self-rating score group I	group II	group III	group IV	Average IQ
		Junior High School boys					
Upper	50	158.7	40.8	40.2	40.6	40.1	115.6
Lower	68	164.4	39.2	38.0	39.1	39.7	101.8
		Senior High School boys					
Upper	46	193.9	40.3	40.7	42.1	41.9	115.9
Lower	61	199.0	40.9	39.8	39.7	38.9	105.8

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[7] As pointed out above, viz, (I) relation to parents, (II) relation to brothers and sisters, (III) relation to associates, and (IV) interaction in general situations not falling in any of the foregoing categories

TABLE 2D

AVERAGE AGE, IQ, AND SELF-RATING SCORES OF BOYS WHO ARE OLDEST AND YOUNGEST CHILDREN

Sibling position	Number of boys	Average age (in mos.)	Average self-rating score group I	group II	group III	group IV	Average IQ
		Junior High School boys					
Oldest	*66*	159.8	41.4	43.1	40.1	39.1	110.5
Youngest	75	158.6	39.4	38.1	39.8	40.4	106.9
		Senior High School boys					
Oldest	58	197.6	40.6	44.8	39.7	39.5	110.6
Youngest	47	197.4	37.6	37.9	41.0	40.3	109.3

average (arithmetic mean) of the scores for all questions in a group as the most satisfactory measure for comparative purposes. Accordingly these average scores (using the weights or scores secured by the method referred to at the end of the preceding section) for the four question groups were determined for each boy. To avoid dealing largely with decimals each score was multiplied by ten. This, of course, did not change the relative values of the scores. Furthermore, in order to change the negative values to positive values the number forty was added to each of the scores. This step was necessary to permit the use of card-sorting and tabulating machines in manipulating the data. The number forty was chosen to be added because the lowest negative score was a minus forty. This score thus became zero.

In each school, when the factor of age was considered, the older boys were found to have the more dominant self-ratings in the intra-familial relationships and the more submissive self-ratings in the extra-familial relationships (Table 2A). This comparison also showed that the younger group in each school had the higher average IQ. When the boys were compared on the basis of IQ, there was found to be a strong tendency for boys with lower IQ's to rate themselves as more submissive than those with the higher IQ's (Table 2B). This was true in all four types of situation, but was most marked in the intra-familial situation. A comparison of average self-rating scores on the basis of socio-economic status[8] revealed small but quite consistent differences between the upper and lower groups, the former having the more dominant scores (Table 2C) However, low socio-economic status is apparently associated with greater average age and lower average IQ, both of which appear to be related to more submissive self-rating scores Hence, it is possible that the relationship just indicated may be due to the age and IQ characteristics associated with socio-economic status When boys who were youngest children in their respective families were compared with those who were oldest children, the greatest difference in average score appeared in the second group of questions, those dealing with sibling interaction (Table 2D). The tendency was for youngest and oldest brothers to be relatively submissive and dominant, respectively, *in the intra-familial ratings, while in the extra-familial* ratings the tendency was reversed, but much less pronounced When the boys of the Selected Group (those selected on the basis of the teachers' ratings as being outstandingly dominant, average, or submissive) were compared with all other boys, the differences in average age, IQ, and self-rating scores were negligible A final comparison was made between the self-rating scores of those boys whose parents returned ratings and those whose parents failed to do so, but no significant selective effect was revealed

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[8] The scale used in classifying the occupations was a recent revision by P. J. Rulon and C. W. Croon (Harvard Univ. Lab. of Ed. Psych.) of the Univ. of Minnesota Institute of Child Welfare scale (1932 revision) of occupational categories. The Minnesota scale is based upon the Barr Scale

The findings for this section may be summarized as follows·

a When age groups were considered, it was found that *younger* boys had higher IQ's, were more submissive on the intra-familial groups of questions, and more dominant on the extra-familial questions *Older* boys had lower IQ's and showed more submissiveness on the extra-familial questions. None of these differences was large.

b When IQ groups were considered, the boys having *lower* IQ's were older, and were more submissive on all groups of questions, *boys having higher IQ's were younger, and were more dominant* throughout

c With regard to socio-economic status, boys coming from families with *lower* status were older, had lower IQ's and were more submissive *Boys coming from families with higher status were younger,* had higher IQ's, and were more dominant.

d. When sibling positions were considered (in fraternities of

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for Occupational Intelligence and the Taussig Industrial Classification (17) The Harvard Scale is an adaptation to the population of Massachusetts of the Minnesota scale, which *lacks many occupations found in Massachusetts* two or more) *youngest* boys were more submissive in Groups I and II, more dominant in Groups III and IV, *oldest* boys showed the opposite tendencies. The greatest divergence of scores was on the Group II questions Since ages were practically the same in both groups of boys this finding is distinct from *a*, above

5. *Experimental Procedure* Inasmuch as the entire study dealt with interactional or social patterns of behavior, the experimenting necessarily centered upon the same phenomenon The principle employed was the same as that used by Henning, at Danzig, in his *Zweipersonen* or dyad experiments, though the techniques used here were much less complicated The procedure was as follows. the attention of two subjects was fixed upon an interesting and natural type of interaction, while the attention of the observer was directed toward the dynamic *process of interaction* rather than at the products of that process

The pairing of subjects for the tests was as follows· only those boys in the Selected Group who were most uniformly rated as dominant, average, or submissive by the teachers were chosen for the experimentation These pupils were then paired in one of the six possible combinations: dominant with dominant, average with average, submissive with submissive, dominant with average, dominant with submissive, and average with submissive. Although perfect agreement of pairs in all respects was hardly attainable, the variable factors of age, grade, and IQ were kept fairly constant. In each grade twenty-four boys were arranged in pairs

The experimentation included five separate projects or situations The first of these involved choosing a picture from several shown by the experimenter After studying the picture selected for a few seconds the boys were to write down as many items as they could remember having seen The second situation involved arranging five small weights according to heaviness. The third experiment was the testing of strength by a dynamometer. The fourth consisted of one boy's drawing a simple object and the other boy's criticizing the completed drawing. In the final test both boys working together produced a single set of answers to those questions included in the self-rating scale which began, "What do most boys do when . ?"

Every precaution was taken, of course, to give the subjects the impression that the number of items recorded from memory, the correctness in arrangement of weights, physical strength, etc , were of primary interest to the experimenter. The observer, however, was noting and recording unobtrusively the interaction between the two boys which would indicate dominant or submissive behavior in the various situations. The items recorded by the observer consisted of certain supposedly significant elements of behavior exhibited by the boys before, during, and after each experiment, such as: Who first reached for or grabbed the object under consideration? Who attempted to control the situation by speaking first? Who advised the other? Who questioned the observer? In scoring these records, each pair of interacting boys was regarded as a qualitatively unique unit, and in every case the only question considered was, *which* of the two boys was the more dominant and which was the more submissive. No attempt was made to construct an absolute scale of dominance permitting the comparison of all boys' behavior in the same units of measurement. If one individual of the pair was dominant four or five times his behavior was regarded as consistently dominant, that of his partner as consistently submissive. If dominant behavior was divided between the pair, or no marked dominance was exhibited by either boy, their behavior was scored as inconsistent. On this basis of division into consistent and inconsistent behavior, thirty-three pairs scored as consistently extreme (D or S) in behavior, thirty-two as inconsistent.[9] However, when the two school groups were treated separately, the ratio of experiments revealing consistent and inconsistent behavior in the Junior High School was 3:2, whereas in the Senior High School it was 2:3. This reversal of proportion may mean that individual inconsistency of behavior increases with age; or it may mean that greater conventionality of behavior prevents the older boys from doing and saying just as they would like, or, finally, it may mean that the experiments as presented were not equally good tests of behavior for both age groups of boys.

The only finding to be presented at this point is the following:

a. The ratio of consistent to inconsistent behavior was much greater in the Junior H. S. group of boys: for them it was 3:2 (actual numbers, 42:28), while for the Senior H. S. boys it was 2:3 (actual numbers, 24:36).

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[9] The findings with regard to the different types of pairs are presented in section 2 of Part IV, following.

IV. ANALYSIS AND INTERPRETATION OF DATA

In this portion of the paper the various types of data secured will be combined and an analysis of these combinations will be attempted in order to discover the consistency or inconsistency which they reveal. The data from the five separate measures (ratings by teachers, self, father, and mother, and experimental data) may be thus combined. teacher-self, teacher-experiment, teacher-father, teacher-mother, self-experiment, self-father, self-mother, experiment-father, experiment-mother, and father-mother. Each of these comparisons must be made separately for the Junior and Senior High Schools.

1. *Teachers' Ratings and Self-Ratings.* The material presented in Table 3, dealing with the self-rating scores of boys grouped according to teachers' ratings, may now be taken up. The boys rated by teachers as "average" ("A") were younger by several months than any other group. The oldest group among Senior High School boys was that rated "S" by teachers. In the Junior High School the same was the case, but to a less marked degree. Again, IQ was found to be inversely related to age, the "A" group, which was youngest, having the highest IQ, and the "S" group, oldest, having the lowest IQ.

TABLE 3

AVERAGE AGE, IQ, AND SELF-RATING, SCORES OF BOYS GROUPED ACCORDING TO TEACHERS' RATINGS

Group of boys	Number of boys	Average age (in mos.)	Average self-rating score group I	group II	group III	group IV	Average IQ
			Junior High School				
Dominant	26	164.0	41.0	39.5	38.6	40.2	107.3
Average	25	158.5	41.5	41.4	40.1	41.2	117.5
Submissive	24	164.8	39.5	39.4	36.6	38.0	104.3
All others	160	162.4	39.6	39.8	40.8	40.0	106.5
			Senior High School				
Dominant	21	197.7	37.8	38.4	38.7	42.9	111.2
Average	25	194.7	39.7	41.8	39.3	41.6	112.3
Submissive	24	200.6	40.9	40.8	41.2	37.0	106.9
All others	122	198.1	40.4	40.7	40.2	40.1	109.7

The average self-rating scores on the first group of questions (dealing with parent-child interaction) revealed some interesting differences between the boys rated by teachers as D, A, or S. The Senior High School boys rated themselves on this situation exactly *inversely* to the degree of dominance attributed to them by teachers. This was completely true of the Group III questions (interaction with associates), and with the exception of the "A" boys applied to the Group II questions (sibling interaction) as well However, in the case of the questions dealing with extra-familial situations—those probably most closely related to the behavior observed by the teachers—the self-rating scores exactly paralleled the teachers' ratings Thus, among the Senior High School boys, the data would indicate that dominance of behavior at home and at school tend to be inverse.

The case was quite different, however, among the Junior High School boys Here the "Average" group, youngest in age and highest in IQ, was highest in average self-rating score throughout the four groups of questions Furthermore, the submissive group, lowest in IQ, was lowest (sometimes by a very slight margin) in average self-rating scores throughout.

To give a satisfactory interpretation of these conflicting results is difficult if not impossible. It is conceivable that the Junior and Senior High School teachers were not using the same subjective norms for evaluating D, A, and S behavior Again, behavior which is characteristic of D, A, and S boys may actually be different in the Junior and Senior High School groups Or there may be greater validity of self-rating among older boys than among younger boys Finally, any combination or all of these possibilities may exist at the same time.

The material presented in this section may be thus summarized:

a Boys rated A by teachers were youngest and had highest IQ's in both school groups In the Junior High School these boys had slightly higher scores throughout. In the Senior High School "A" boys had, with one exception, scores falling between those of the "D" and "S" boys

b Boys rated D by teachers were intermediate as to age and IQ, those in the Junior High School had scores lower than those of the A group, but also higher than those of the S group, throughout

c Boys rated S by teachers were oldest and had lowest IQ's Junior High School boys of this group had the lowest self-rating scores throughout. Senior High School boys of this group rated themselves highest on Question Groups I, II, and III, and lowest on Group IV

d In general, Junior High School boys occupied relatively the same position throughout. Senior High School boys, on the other hand, tended to agree with teachers' ratings only on Group IV questions, and to rate themselves inversely on all other groups of questions.

2. *Teachers' Ratings and Experimental Data.* The second comparison—teachers' ratings with experimental data—is presented in Table 4. The three vertical divisions represent the groups of boys rated by teachers as dominant, average, and submissive. The vertical subdivisions, headed "D", "A", and "S", represent the experimental determination of dominant, average, and submissive behavior.

TABLE 4

EXPERIMENTAL BEHAVIOR COMPARED WITH TEACHERS' RATINGS, ARRANGED ACCORDING TO TYPE OF EXPERIMENTAL PAIR

Teachers' ratings	Dominant			Average			Submissive		
Experimental results	D	A	S	D	A	S	D	A	S
Type of pair—based on Teachers' ratings									
Similar Pairs									
D and D									
Junior H. S.	3	4	3						
Senior H S	0	6	0						
A and A									
Junior H S.				4	4	4			
Senior H. S				2	8	2			
S and S									
Junior H. S							3	4	3
Senior H S							2	6	2
Dissimilar Pairs									
D and S									
Junior H. S.	4	1	1				1	1	4
Senior H. S	1	3	0				0	3	1
D and A									
Junior H S	1	4	1	1	4	1			
Senior H S.	6	2	0	0	2	6			
A and S									
Junior H S				3	3	1	1	3	3
Senior H S.				1	3	0	0	3	1

The upper half of the table deals with *similar pairs,* i e., those in which individuals rated similarly by teachers comprised an experimental pair. The lower half shows the findings when dissimilarly rated individuals comprised the experimental pairs. For instance, the bottom row of figures shows that of the four average-submissive experimental pairs (in the Senior High School) only one showed marked differentiation of behavior. One individual in this last pair, therefore, rated average by teachers, was scored D in the experimentation, while his partner, rated submissive by teachers, was scored S The other three pairs in this row showed such similarity in dominance of behavior as to yield experimental scores of A for each of the individuals involved The other rows are to be interpreted similarly.

Returning to an examination of the upper half of the table, it will be seen that the Junior High School boys, when matched as nearly as possible for age, IQ, and teachers' ratings, still tended to reveal differences of dominance and submissiveness of behavior in the experimentation. Under similar conditions the Senior High School boys showed much less of this tendency toward "extremeness" of behavior If the pairings were valid, and if behavior were consistent, the result to have been expected from experimenting with similarly rated boys would have been the absence of clear-cut differences in behavior—that is, experimental scores of A. This expectation was more closely realized among the Senior High School than among the Junior High School boys, over two-thirds of the former showing no clear-cut differences as compared with only one-third of the latter

Among the dissimilarly rated pairs, the expectation would have been for all pairs of boys to show clear extremes of behavior. This hypothesis was confirmed by less of the older boys (one-half as compared with two-thirds) and more of the younger boys (seven-sixteenths as compared with one-third) than was the case among the pairs of similarly rated boys Nevertheless, both in similar and in dissimilar pairs, the expected conditions were realized more closely by the older group Apparently greater consistency, therefore, was found in the behavior of the older boys

Assuming this conclusion to be valid, the question arises as to why the expectation in the case of "average" behavior (according to teachers) was more fully realized than in the case of extreme behavior among the Senior High School boys, while the reverse was true of the Junior High School boys. An interpretation may be suggested. In the first place, perhaps with increasing age there is a tendency for individual behavior to become more "consistent" in a broad, comprehensive way. Possibly a "pattern" becomes more clearly discernible in the individual's behavior In a general way it may be possible to predict with increasing accuracy the type of behavior which will ordinarily be exhibited by the individual. The higher agreement between teachers in rating Senior High School boys bears out this point of view. In the second place, paradoxical as it may seem, with increasing age there appears to be a distinct tendency for individual behavior to become differentiated in more narrow, specific ways; immature, unsophisticated attempts to gain every desired goal by blindly following the same self-assertive methods give way to socially more acceptable, diversified forms This dual tendency may account for the fact that the total proportions of boys exhibiting extreme behavior are reversed in the two school groups.

This conclusion—that with increasing age there is a tendency for boys to show greater steadiness or continuity of basic behavior trends, together with increasingly precise adaptation of actions to the requirements of social situations—appears to permit the positing both of social conditioning of behavior and of stable personality traits This interpretation, however, will be modified and amplified in section 4, below.

The following findings summarize the data derived from an analysis of teachers' ratings and experimentation:

a. Where non-extreme behavior was expected (similar experimental pairs) Senior High School boys conformed in 71 per cent of the cases, Junior High School boys conformed in 37 per cent of the cases

b Where extreme behavior was expected (dissimilar experimental pairs) Senior High School boys conformed in 50 per cent of the cases; Junior High School boys conformed in 42 per cent of the cases

c. Among Junior High School boys, four subjects behaved in the experimentation antithetically to expectation on the basis of teachers' ratings (e g., a boy rated D behaving submissively in the experimentation). No such reversals were found among Senior High School boys

d The total proportion of behavior scored as extreme (D or S) in the Junior High School group was 60 per cent, among the Senior High School boys it was 40 per cent. In other words, the total amount of non-extreme behavior was relatively half again as large among Senior as among Junior High School boys

3 *Fathers' and Mothers' Ratings.* Pearsonian coefficients of correlation were derived as the most convenient means of expressing the

degree of relationship found between the average scores of fathers and mothers for the four separate groups of questions (see Table 5).

TABLE 5

CONSISTENCY BETWEEN FATHERS' AND MOTHERS' RATINGS OF SONS FOR THE FOUR GROUPS OF QUESTIONS—MEASURED BY COEFFICIENTS OF CORRELATION

	Group I	*Group* II	*Group* III	*Group* IV
Junior High School	+ 51	+ 72	+ 34	+ 71
Senior High School	+ 54	+ 46	+.41	+ 58

The lowest *r's* were found in the third group of questions, concerning interaction with associates, and the highest *r's* appeared in the group of questions involving general situations There was greater disagreement among parents of Senior High School boys as to their rating on sibling interaction questions than was true among parents of Junior High School boys Parents of the older boys agreed most closely on the questions dealing with fairly general situations

It is of particular interest to note that the relatively close agreement of Junior High School boys' parents on two groups of questions (II and IV) was not paralleled by equally close agreement on the other two groups of questions But although agreement among parents of the older boys did not run so high on any one group of questions, neither did it fall so low. In other words, the degree of agreement remained more nearly the same for all types of situations. This might be the result of diminished specific knowledge of sons' behavior on the part of fathers, or mothers, or both, with a consequent greater reliance on their knowledge of their sons' general behavior tendencies.

The findings for this section may now be presented·

a Pearsonian *r*'s between fathers' and mothers' ratings on both Junior and Senior High School boys and for each group of questions were positive Seven out of the eight coefficients were over three times the size of their respective standard deviations.

b The highest *r*'s appeared when ratings on the fourth group of questions were correlated; the lowest were found on the third group of questions.

c The degree of agreement between parents ratings was lower, but more nearly the same throughout all four groups of questions, among parents of Senior High School than of Junior High School boys.

TABLE 6

AVERAGE PARENTS' RATING SCORES OF BOYS RATED BY TEACHERS AS DOMINANT, AVERAGE, AND SUBMISSIVE*

Teacher's rating.	Dominant				Average				Submissive			
Group of questions	I	II	III	IV	I	II	III	IV	I	II	III	IV
Junior High School												
Fathers	41.9	46.6	46.4	42.5	35.4	41.0	41.3	40.0	44.7	26.0	32.3	37.3
Mothers	42.7	41.4	41.1	42.8	37.3	38.8	37.2	39.5	39.5	38.1	43.6	38.1
Senior High School												
Fathers	45.7	41.0	39.5	41.5	36.9	37.6	42.8	42.9	37.0	39.2	35.6	32.3
Mothers	43.3	44.0	43.2	44.8	39.1	37.1	40.7	41.1	38.4	40.7	36.5	35.4

*Boys who had no brothers or sisters obviously could not be rated on the second group of questions, and hence these "only" children are not included in the scoring on this question.

4 *Teachers' Ratings and Parents' Ratings.* The scores for fathers' and mothers' ratings for each of the dominant, average, and submissive groups of the Junior High School and Senior High School are presented in Table 6. For the Junior High School group, in only one group of questions did fathers, mothers, and teachers agree perfectly—the fourth No such agreement was to be found in the other three groups of questions. Boys regarded by teachers as submissive, for instance, were regarded by parents as typically exhibiting in some situations more dominant behavior tendencies than boys rated D and A by teachers. Among Senior High School boys, although perfect agreement did not appear, the closest approach to agreement was again found in the fourth group of questions. Boys rated A by teachers were, according to both fathers and mothers, more submissive than average in the intra-familial situations and more dominant than average in the extra-familial situations When only the D and S groups were compared, in each of the eight possible instances (fathers' and mothers' ratings on the four groups of questions) parents rated the former higher than the latter, i.e., more dominant. On the whole, furthermore, there was much greater similarity between fathers' and mothers' ratings of any one group than was true among the parents of Junior High School boys Thus a comparison between these data for the two school groups also supports the interpretation set forth earlier· viz., that with increasing age it becomes possible to define more accurately the general pattern of an individual's behavior. But the tentative conclusion presented at the end of section 2 (above) must be modified in the light of the foregoing data What were spoken of as "stable personality traits" and "basic behavior trends" seem to be "stable" or "basic" only in terms of a single, general, or possibly an "institutional" environment. Increasing consistency of behavior may be true within one or more such "institutional environments," but knowledge of typical behavior in one such general environment (e.g., the school) apparently does not enable prediction regarding typical behavior under another general set of circumstances (e.g , the home) In fact, the types of overt behavior under different "institutional" conditions may be reversed

To turn from interpretations to facts, the following findings may be presented

a. There was somewhat less variability among mothers' than among fathers' ratings.

b. Only on Group IV questions did Junior High School parents and teachers' ratings agree perfectly.

c. Junior High School boys rated by teachers as S were in some cases rated higher by parents than were D and A groups.

d. Among ratings of Senior High School boys, highest (though not perfect) agreement was also found on Group IV questions.

e. There was greater similarity between average ratings of fathers and mothers in the Senior High School group than was the case among Junior High School parents.

f. When only Senior High School D and S boys were compared, their parents in each case rated the latter *lower* (i.e., as being more submissive) than the former.

5. *Self-Ratings and Experimental Data.* Average self-rating scores among the Junior High School boys showed no clear similarity to the experimental ratings except in the group of questions (III) dealing with playmate interaction (see Table 7). In this case the highest, middle, and lowest self-rating scores (size of score indicating degree of dominance) were made by the boys found in the experimentation to be D, A, and S, respectively. Among the Senior High School boys the same relationship held only for the fourth group of questions, all others showing considerable variability, and no definite trends. From these data it appears that self-evaluations of behavior on questions dealing with intra-familial behavior show no positive relationship to measures based on extra-familial behavior such as that exhibited under experimental conditions.

TABLE 7

AVERAGE AGE, IQ, AND SELF-RATING SCORES OF BOYS SCORED IN THE EXPERIMENTS AS D, A, OR S*

Experimental score	Number of boys	Average age (in mos.)	Average self-rating score group I	group II	group III	group IV	Average IQ
		Junior High School					
D	21	161.3	41.3	38.1	40.2	40.4	112.1
A	28	164.3	39.7	41.6	39.3	38.8	109.7
S	21	161.3	41.1	40.8	35.4	39.2	108.7
		Senior High School					
D	11	191.5	38.1	35.7	38.5	42.5	114.0
A	35	199.2	43.8	42.9	40.7	40.2	110.2
S	12	190.8	33.2	36.9	39.3	39.6	111.4

*Senior High School group lacks self-rating data on two boys.

When scores were averaged separately for the two groups of Junior High School boys—those in the "similar-pair" experiments and those in the "dissimilar-pairs"—two clear-cut trends were apparent. First, the tendency noted above in the Group III questions (for self-rating scores to parallel experimentally determined behavior type) became more marked for boys in the dissimilar pairs. On the other hand, for boys in similar pairs, the average scores for the Group II questions (sibling interaction) were in inverse order to the experimental scorings Thus again we have the appearance of an inverse relationship between measures dealing with intra- and extra-familial situations. It will be noted that these data give further support to the interpretation submitted in the preceding section

The findings are as follows

a. Boys exhibiting the least extreme behavior were somewhat older than those whose behavior was extreme (i.e., D or S); this was true both of the Junior and the Senior High School groups.

b Boys scored as dominant in the experimentation had slightly higher IQ's on the average than those receiving average or submissive scores

c. Average self-rating scores paralleled experimental ratings only on Group IV questions—those dealing with general extra-familial behavior, this was true of the boys in both school groups.

6 *Self-Ratings and Parental Ratings*. The Pearsonian coefficients measuring relationships between ratings by boys and those by their parents are presented in Tables 8 and 9. In general the correlations between the scores on the self-ratings and the scores on parental ratings were found to be very low, the highest correlation being

TABLE 8

CONSISTENCY BETWEEN AVERAGE SELF-RATING SCORES AND PARENTS' RATING SCORES FOR THE FOUR GROUPS OF QUESTIONS—MEASURED BY COEFFICIENTS OF CORRELATION

Self-rating scores correlated with	Group I	Group II	Group III	Group IV
	Junior High School			
Fathers' ratings	+ 04	+ 16	+ 11	+ 28
Mothers' ratings	+ 31	— 11	—.08	+ 33
	Senior High School			
Fathers' ratings	+ 02	— 07	— 16	+ 36
Mothers' ratings	+ 23	+ 02	+ 04	+ 52

TABLE 9

CONSISTENCY OF SELF- AND PARENT-RATING SCORES BETWEEN SUCCESSIVELY PAIRED GROUPS OF QUESTIONS AS MEASURED BY COEFFICIENTS OF CORRELATION

	(1) Groups I and II	(2) Groups II and III	(3) Groups III and IV	(4) Groups I and IV
Self-ratings				
Junior High School	+ 33	+ 12	+.07	— 07
Senior High School	+ 37	+ 18	+ 09	— 07
Fathers' ratings				
Junior High School	+ 31	+ 26	+ 42	+ 23
Senior High School	+ 31	+ 02	+ 09	+ 08
Mothers' ratings				
Junior High School	+ 51	+ 23	+ 46	+.19
Senior High School	+ 17	+ 07	+ 21	+ 17

in the case of the Group IV questions (Table 8). In the case of the questions concerning parent-child interaction (Group I), mothers' and sons' ratings agreed more closely than did fathers' and sons' ratings. When coefficients of correlation were derived between boys', fathers', and mothers' average scores on successively paired groups of questions (I and II, II and III, III and IV—intrafamilial, non-adult, and extra-familial interaction, respectively) the *r*'s in the self-ratings were too low to enable one to make accurate predictions (see Table 9). There was a decline in the size of the coefficient through the successive sections of the self-rating scale, which was not duplicated in any of the sets of parents' ratings. This may be interpreted as meaning either that there is less consistency in the boys' extra-familial behavior than in their domestic relationships, or that parents are better judges of typical behavior than are sons

The *r*'s between the mothers' and fathers' ratings showed greater homogeneity of behavior type in boys' familial relationships (column 1), and also in their non-familial relationships (column 3), than when these two spheres of behavior were combined (columns 2 and 4).

In practically every instance the *r* was higher for Junior than for Senior High School boys. The greater inconsistency of behavior thus revealed in the latter group is to be expected on the basis of the inverse relationships previously indicated between various parts of the self-rating data for this group

The findings for this section are now presented.

TABLE 10

Average Parents' Rating Scores of Boys Whose Behavior in the Experimentation was Scored D, A, or S

Experimental score	D				A				S			
Group of questions	I	II	III	IV	I	II	III	IV	I	II	III	IV
					Junior High School							
Fathers	42.0	39.4	38.7	39.5	38.7	44.4	47.7	41.6	40.1	41.0	39.6	40.4
Mothers	43.5	40.7	43.0	42.0	38.2	39.8	38.5	40.5	38.4	37.7	41.5	38.4
					Senior High School							
Fathers	39.1	37.8	44.4	33.6	41.2	40.1	38.4	40.8	42.6	38.1	42.0	41.3
Mothers	42.2	43.3	45.2	44.2	40.9	39.5	41.9	39.2	40.1	38.3	34.1	41.0

a. Highest coefficients in all cases were found for Group IV questions.

b All other correlations, except between mothers' and self-ratings for Group I, were very slight or negative—practically insignificant

c. Agreement between self-ratings on successive pairs of question groups was slightly greater among the Senior than among the Junior High School boys

d. Agreement was closest between self-ratings on Groups I and II (intra-familial relationships).

e. Similarity between parents' ratings on successive pairs of question groups was greater in each case when intra-familial and extra-familial questions were considered than when these two spheres of behavior were combined.

f Similarity between parents' ratings on successive pairs of question groups was less for Senior than for Junior High School boys in five out of six comparisons.

7. *Experimental Results and Parents' Ratings*. The ratings of parents of the Junior High School boys showed slight agreement with the experimental data (see Table 10). Fathers' ratings showed practically no relationship to the experimental results, but the mothers' ratings gave highest scores to boys who were scored "D" in the experimentation The mothers' ratings on Question Groups II and IV *were comparable to the experimental results*

The ratings of parents of Senior High School boys when compared with experimental results showed similar variation. Fathers rated sons inversely to their experimental scores in Groups I and IV. Mothers, on the contrary, rated their sons parallel to the experimental findings on all groups of questions but the last. But they rated the more dominant boys consistently higher than they did either of the other two groups

Probably the most significant observation to be made on the basis of this comparison is that the experimental scores were most closely paralleled by mothers' ratings of boys found to be dominant in the experimental situation.

The final group of findings is as follows·

a Mothers' ratings agreed most closely with experimental scoring in the cases of boys behaving dominantly.

b Mothers' ratings also agreed with experimental scores in relative size of scores given D, A, and S boys on Groups II and IV for the Junior High School, and on Groups I, II, and III for the Senior High School.

c Fathers' scores revealed practically no reliable relationship to the experimental scores.

V Conclusions

Three generalizations or interpretations bearing on the problem of consistency of dominant and submissive behavior may now be put forward.

First, apparently there is a tendency for boys as their age increases to show an increasing differentiation of behavior as to dominant and submissive characteristics That is, the behavior of the older boys seems to show a more intricate pattern, when details are considered, than does that of the younger boys. Minute samples of behavior (for instance, a rating by an individual teacher) reveal greater heterogeneity among the older than the younger boys Apparently the specific elements in situations tend increasingly to modify older boys' behavior. This modification is away from extreme forms of domination and submission, and toward more conventional modes of behavior This interpretation is supported by the above findings numbered III 1*a*, 1*b*, 1*c*, 5*a*; IV 2*a*, 2*b*, 2*d* and 5*a*.

Second, there appears to be a tendency for the type of behavior (D or S) *within a general environment* to become more clearly definable, consistent, and predictable with increasing age The preceding paragraph dealt with the details, the narrower aspects of behavior Here we are dealing with its broader and less precisely measurable aspects It seems that among the older boys there is a greater stability of basic behavior pattern within a general environment However, this is not discernible from an examination confined to small, segmental samples of behavior It is to be noted that "general environment" does not refer to the entire range of behavior This interpretation, which is not irreconcilable with that of the preceding paragraph, is supported by the findings numbered: III 1*e*, 1*f*, IV 1*d*, 2*c*, 4*e*, 4*f*, and 6*c* Finding IV 6*f* is contradictory to this interpretation.

Third, as the age of the subjects increases, dominant-submissive behavior tendencies within one general environment may be ascertained with increasing reliability, but at the same time it becomes less possible, on this basis, to predict such tendencies in another general environment. For example, as boys become older it seems more possible for school teachers to predict reliably their behavior type (D or S) in the general school environment, but less possible to predict, on this basis, the type of behavior characteristic of intrafamilial relationships. Thus the findings of this study seem to indicate that different characteristic modes of behavior appear in extra- and intra-familial relationships. Although the evidence is not unequivocal, these differences may perhaps justify the conception of school (one of the broad extra-familial environments) and home as two distinct, "institutional," environments. The various findings which lend support to such an interpretation are these: III 4*a*, 4*d*, IV 4*b*, 4*d*, 5*c*, and 6*e*. Two findings, on the other hand (IV 4*f* and 7*a*), tend to suggest that typical behavior is not markedly different in various environments.

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UNE ÉTUDE DE LA CONSTANCE DU COMPORTEMENT DOMINANT ET SOUMIS CHEZ LES GARÇONS ADOLESCENTS

(Résumé)

Dans cette étude il s'agit de la constance du comportement dominant et soumis chez 70 élèves de la Junior High School et 50 élèves de la Senior High School On a obtenu l'âge chronologique, les données du Q.I, et les quatre types suivants de renseignements sur le comportement dominant et soumis des sujets (1) les évaluations des maîtres d'école, (2) les évaluations des parents, (3) les évaluations par les garçons eux-mêmes, (4) des données expérimentales. Pour donner un contrôle interne sur l'étude on a traité séparément partout les données des deux groupes Pendant *le progrès de l'étude, cependant, il s'est montre des différences significantes* entre les résultats pour le groupe des plus jeunes et le group des plus âgés, de 162 et de 198 mois, respectivement. Ces différences ont été si grandes qu'on n'a pu faire des généralisations sur les sujets comme seul groupe chronologique En effet, on a pensé que les résultats montrent des changements génétiques dans la constance du comportement. (1) Apparemment les garçons ont tendu, avec l'avancement de l'âge, à montrer une différentiation accroissante du comportement à l'égard des traits dominants et soumis (2) Il paraît que le type du comportement *dans un milieu général* (tel que "la maison" ou "l'école") a tendu à devenir plus constant et plus facile à prédire avec l'avancement de l'âge. (3) En même temps, *cependant, il est devenu moins possible sur* la base de la connaissance des tendances au comportement dominant-soumis dans un milieu général de prédire de telles tendances dans un autre milieu général

SCHULER

EINE UNTERSUCHUNG DER BESTANDIGKEIT VON HERRSCHENDEM UND UNTERWÜRFIGEM VERHALTEN BEI JUGENDLICHEN KNABEN

(Referat)

Dieses Studium handelt von der Bestandigkeit des herrschenden und unterwufigen Verhaltens bei 70 Knaben einer hoheren Schule im vorletzten Jahr und 50 im letzten Jahr Chronologisches Alter, I Q, und die folgenden Auskunfte uber das herrschende und unterwurfige Verhalten der Knaben wurden erhalten (1) Beurteilungen der Lehrer, (2) Beurteilungen der Eltern, (3) Selbstbeurteilungen, (4) experimentelle Angaben Um eine experimentelle Nachprufung der Untersuchung zu ermoglichen, wurden die Angaben fur die beiden Gruppen durchweg getrennt behandelt. Im Laufe der Untersuchung erschienen aber bedeutsame Unterschiede zwischen den Befunden fur die jungeren und alteren Gruppen, die im Durchschnittsalter von 162 und 198 Monaten waren Diese Verschiedenheiten waren so gross, dass sie eine Verallgemeinerung uber die Vpn als Gruppe mit *einem* Durchschnittsalter verhinderten In der Tat schien es nachgewiesen zu sein, dass die Befunde genetische Anderungen der Bestandigkeit des Verhaltens offenbarten. (1) Scheinbar bestand die Neigung bei Knaben mit zunehmenden Alter eine zunehmende Differenziertheit des Verhaltens in bezug auf die herrschenden und unterwurfigen Eigenschaften zu zeigen (2) Auch schien die Neigung beim Verhaltungstypus innerhalb einer gemeinsamen Umgebung (wie "zu Hause" oder "Schule") bestandiger und voraussagbarer mit zunehmendem Alter zu werden (3) Gleichzetig wurde es aber weniger moglich, auf Grund der Kenntnisse der herrschend-unterwurfigen Verhaltungsneigungen in einer gemeinsamen Umgebung solche Neigungen in einer anderen gemeinsamen Umgebung vorauszusagen

SCHULER

PSYCHOMOTOR EDUCATION AND THE GENERAL DEVELOPMENT OF PRESCHOOL CHILDREN: EXPERIMENTS WITH TWIN CONTROLS*

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I. Introduction

The present investigation has sought to analyse the influence of psychomotor training upon the general development of the child of preschool age. An equally important question has also been studied, viz., the degree to which psychomotor functions of different complexities are conditioned genotypically and paratypically.

The literature concerning the interrelations between genotypical and paratypical factors in the general development of the child is quite rich, data on the relative importance of hereditary and environmental factors in psychomotor development are, however, very scanty.

Gesell and Thompson (1), on the basis of their data (an investigation of one pair of identical twins), arrive at the conclusion that motor education is of almost no importance in the general development of the child, since internal processes of growth play a greater rôle than external influences. According to Gesell, then, if any success is attained by means of training, natural growth tends to replace or to substitute the results of training. The work of Gubert, Leningrad, on infants has shown that special gymnastics administered to infants considerably advanced their physical and motor development. Hetzer and Wolf (2) maintain that children raised under unsatisfactory conditions are backward with regard to psychomotor development as compared with those raised under satisfactory conditions, and that through improvement of conditions backward children may be brought up to normal.

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*Accepted for publication by A. R. Luria of the Editorial Board and received in the Editorial Office May 9, 1934.

II. MATERIALS AND METHODS

Twins have served as subjects in this investigation because the twin method gives the best opportunity to determine the influence of external factors upon the child, through comparisons of trained (experimental) with untrained (control) identical twins (OET's);[1] In order to obtain information on the degree of genotypical or paratypical conditioning of psychomotor functions, the method of comparison of OET's with TET's (fraternal) was applied Especial attention was devoted in this study to systematic observations of the twins, to inquiries among parents and teachers, and to diary records The method of tests was applied only for general information, in determining mental and motor development at the beginning and the end of training. In determining mental development the generally adopted Stanford-Binet was applied. In Table 1 are presented data on the intellectual development of OET's and TET's It may be seen from this table that intrageminal resemblance is nearly two and one-half times greater in OET's than in TET's.

TABLE 1

THE MENTAL DEVELOPMENT IN OET'S AND TET'S (IQ ACCORDING TO BINET AND TERMAN)

OET's					TET's				
Pairs	IQ	IQ	D		Pairs	IQ	IQ	D	
M	113	102	11	Mean for	P	100	95	5	Mean for
L	97	97	0	4 pairs	A	112	100	12	6 pairs
G	98	94	4	D = 4.5	K	95	80	15	D = 11.1
P	98	101	3		M	123	102	21	
					T	98	89	9	
					B	90	85	5	

In order to determine motor endowment we have used the method of Dr. Oserezky In determining by this method the coefficient of motor endowment it is necessary to begin the tests a year below the chronological age of the subject. Because this method offers no tests for ages under four years, we could not determine precisely the *coefficient of motor endowment of our four-year-old twins* The data obtained by this method could serve therefore only as preliminary material, viz., for selecting inferior partners for training, and as auxiliary data for final judgment of the results

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[1] OET and TET designate identical (one-egg) and fraternal (two-egg) twins, respectively.

The Medico-Biological Institute has organized a group of twins at its Kindergarten. We were able to conduct our experiments and observations in this Kindergarten under more uniform and natural conditions than those which were present in Gesell's studies. In our work the Kindergarten served as an observation clinic. It was of great help in making a careful study of individual peculiarities of the children We had the opportunity of studying children under experimental conditions and in the course of their ordinary group life, and could observe the results obtained from training not only with regard to exercises proposed during the experiment, but also from their ordinary free activity

For our studies four pairs of OET's and six pairs of TET's (all of them were like-sex) from four to four and a half years of age were used The majority of them were children of workers. The diagnosis of identity of the twins was established by the Department of Genetics of the Institute on the basis of the similarity method (Siemens). The similarity of all the physical characters of the OET's was outstandingly great In behavior and mental traits, however, no such great resemblance could be found

Apart from the above tests, we have also studied the following points: (1) games and interests, (2) attitude towards environment, (3) attitude towards the group, (4) regimen and food, (5) attitude of the children toward one another, (6) mood, (7) temperament, and (8) speech.

On the whole, a greater similarity in all these elements could be noted in OET's than in TET's, though considerable differences were occasionally observed in OET's If these differences in OET's are expressed by the words "more" or "less" (for instance, in the pair L. Mania is more compliant than Nunia, Mania is less tender than Nunia), then in the case of TET's, we often find mutually exclusive traits (for instance, the pair K,—Katia is resolute, active; Zina—irresolute, passive, Katia is gay, motile, Zina—morose, immobile). In short, we often meet in TET's the situation that one partner is the opposite of the other, this was never the case in OET's.

Prior to beginning the training (which was intended only for OET's) observations on the behavior of each separate OET pair were conducted over periods of 8 to 10 days. Analogous observations on behavior were repeated towards the end of the training. The aim of these observations was to determine, through data secured at the beginning and at the end of the training, whether any changes of behavior of the twins took place under the influence of special training of the psychomotor functions.

After having carefully made these observations under every-day conditions and after giving the tests, we proceeded directly to testing OET's and TET's By means of comparisons of the data secured, we intended to find out to what extent the psychomotor functions are conditioned genotypically and to what extent paratypically Both groups of twins were given the same exercises—jumping in the air, and hitting a mark by throwing or rolling a ball The technique of the tests and the experiment was as follows For jumps an adjustable cord was used The height of the jumps was measured in centimeters. For hitting the mark two boards were prepared, one for throwing, another for rolling. On the first board circles of different diameters were traced The size of the mark could be adjusted by means of a slide at 10, 15, or 20 centimeters The results of each throw (hitting or missing) were estimated in points, according to the neatness of the hits. The other board was divided into centimeters to allow registration of deviations of the ball in rolling The distance from the point of throwing to the mark was one meter, and the distance from the point of rolling to the mark was two meters.

III. The Problem of Genotypical and Paratypical Conditioning

In approaching the problem of genotypical and paratypical conditioning of psychomotor functions of the child, we were at once confronted with the following important question—are psychomotor functions of lesser complexity and psychomotor functions of greater complexity conditioned to the same degree, genotypically and paratypically?

In psychomotor processes there may be involved, indeed, forms of activities which are far from being similar as regards their complexity, and which are characterized by different psychological structures Those that develop automatically and do not involve any complex intellectual regulation may be called elementary; jumping in the air, and simple lifting of weights may be classified here. Other actions, involving complex processes of arbitrary coordination of movements which follow a definite intellectual scheme, should be classified as a separate group of complex (or higher) psychomotor processes. In this category fall such actions as the accomplishment of complex coordinations according to a definite scheme, or complex constructive motor activities.

The question naturally arises, are the two motor processes which differ in their psychological construction conditioned genotypically and paratypically to the same degree, or do they differ in this respect, and if so, to what extent?

To answer this question we must analyse in succession the three series of experiments performed. The first of them dealt with the most elementary actions, the second with more complex coordinations though taking place in the direct optical field, and the third with a very complex process—coordination of movements according to an internal scheme. Our investigation sought to determine to what extent these processes are conditioned genotypically and paratypically.

EXPERIMENTS WITH JUMPING IN THE AIR

Let us consider the results of our first method, which was that of asking the child to jump in the air. The task consists of a simple coordination of movements, intended to produce a push upward and onward. The internal and external structure of the motor action is very simple. If we consult Table 2, we note that the differences between the OET's pairs are on the average almost four and a half times less than in the case of TET's, which indicates

TABLE 2

INTRAGEMINAL DIFFERENCES IN THE HEIGHT OF JUMPING (CENTIMETERS)

Pairs *OET's*	Twin *A*	Twin *B*	d for *each*	*d mean*	Pairs *TET's*	Twin *A*	Twin *B*	d for *each*	*d mean*
M	0	5	5		P	0	10	10	
L	0	0	0		A	10	10	0	
G	10	12	2	1.75	K	0	10	10	7.6
P	10	10	0		M	0	10	10	
					T	2	10	8	
					B	—	—	—	

that the genotype plays an important part in the variation of this function.

It should be noted that OET's exhibit great similarity in the way they jump and in general behavior, while TET's show striking differences.

Let us proceed next to the data of the second method, i.e., to experiments with throwing the ball, a more complex operation than that considered above. It does not involve, however, any complex intellectual-motor organization, since the decisive rôle is played here by simple judgment of the eye and motor coordination of arm and eye.

The whole process of hitting the mark, indeed, develops here in the direct optical field. The coordination of movements in this case is not a complex act of realization of movements according to a certain internal scheme, but is simply a realization of an elementary sensory-motor structure.

What is the extent of genotypic conditioning of this activity? Table 3 answers this question. It may be seen that the four OET's pairs exhibit again a greater intrageminal similarity than the six TET pairs. While the former never exhibit a difference in precision of movements exceeding 0.5 points, the lowest value for TET's is 1.0 points. The experiments thus reveal that the intrageminal resemblance of this function in OET's exceeds almost six times that in TET's, since these values are obtained from equivalent material, they may be considered fairly dependable, and a considerable connection of elementary motor coordination with the genotype appears to be indicated.

TABLE 3

INTRAGEMINAL DIFFERENCES IN HITTING THE MARK BY THROWING THE BALL. THE PRECISION IS EXPRESSED IN POINTS

Pairs OET's	Twin A	Twin B	d for each	d mean	Pairs TET's	Twin A	Twin B	d for each	d mean
M	1.8	2.0	0.2	0.25	P	1.8	3.3	1.5	1.47
L	1.0	1.5	0.5		A	1.8	2.8	1.0	
G	3.3	3.5	0.2		K	2.1	4.0	1.9	
P	1.2	1.3	0.1		M	0.3	1.8	1.5	
					T	2.0	3.0	1.0	
					B	1.6	3.5	1.9	

In addition to the above experiments we conducted a further and different one—that of hitting the mark by means of *rolling* the ball The operation here is not the simple simultaneous coordination of movements in an optical field with which we dealt in the preceding experiment. From the beginning the child is here compelled to make a successive coordination of movements. The child fixates the goal first, then watches the hand which holds the ball. After preliminary trials the child proceeds to a still more complicated coordination which occurs no longer in the optical but in the purely motor field; fixating the mark the child must act without looking at his hand, the movements of which are coordinated in a purely motor way The optical coordination is replaced here by a more complicated coordination process, according to a certain internal scheme which must be created by the child in the course of the preceding "trials"; instead of a motor extension of sensory structure (which was the case in the second experiment), this act involves as its principal feature the intellectual establishment of a new motor coordination

Table 4 shows the results of the experiments and confirms the statements made above We see that the results of hitting the mark are quite variable in both OET's and TET's. Deviations expressing the degree of precision of hitting, such as a minimum of from five to eight centimeters and a maximum of from 30 to 40 centimeters, occur within both groups. In spite of the mean values which at first sight may appear impressive, the results are not clear, the figures obtained for the OET's do not indicate the same degree of similarity in this activity as was observed for the more elementary functions.

TABLE 4

THE INTRAGEMINAL DIFFERENCES IN HITTING THE MARK BY ROLLING THE BALL. DEVIATIONS ARE EXPRESSED IN CENTIMETERS

Pairs OET's	Twin A	Twin B	d for each	d mean	Pairs TET's	Twin A	Twin B	d for each	d mean
M	45	14	31	15 0	P	21	50	29	23.8
L	30	20	10		A	22	35	13	
G	35	21	14		K	26	50	24	
P	35	40	5		M	22	30	8	
					T	5	50	45	
					B	—	—	—	

Thus two related operations prove to be essentially different in kind, and a clear intrageminal relation between OET's may be observed only in the operation which is of a rather simple structure (a direct coordination of movements in an optical field) while a more complicated operation (movement coordination outside of the direct optical field) shows a far higher fluctuation in OET's.

IV TRAINING

After securing data from preliminary tests, we attempted to set up experimental conditions which would show to what degree psychomotor functions may be developed by training To put it in another way, what is the influence which special external agencies exert upon the development of psychomotor functions and, in particular, to what degree may training be reflected in motor functions of elementary and complex psychological structure?

For this purpose we used the method of reciprocal control of OET's. Every pair of OET's was separated on the basis of test data, pedagogical observations, and general characteristics. The less advanced and less active partners were subjected to a special training of psychomotor functions for a period of four months and a half Those of comparatively higher mental development were kept as controls Inferior partners were selected for training, in order to make clearer the results of the treatment applied.

The childen were given the same exercises every morning for 30 to 40 minutes These exercises were the same as those applied in control tests, i.e , jumping over the cord, and hitting the mark by throwing or rolling the ball Drawing, cutting out, modeling, hammering in nails, sawing, and walking along a board (exercise of the sense of equilibrium) were also offered as exercises The latter were applied alternatively and not every day. This method of training kept the children interested without making them tired The variety of exercises employed the motor equipment to a fuller extent and stimulated its development in various directions, which is important because the motor functions as a whole represent complex and varied structures. The above exercises involved the following basic components· precision and velocity, rhythm, equilibrium, proportionality, and coordination of movements Apart from the training of the motor functions enumerated above,' great attention was devoted to several habits, such as manufacturing appliances and arranging them. The recording of behavior was done on the spot. The exercises followed one another in a definite sequence The first exercise consisted of jumping in the air, the second in hitting the mark by throwing the ball, and the third in rolling the ball.

After four months and a half both the control and trained twins were subjected to control examinations again We were able to conclude with certainty that great changes in development of the psychomotor functions had taken place as a result of our training. It appeared, moreover, that the quantitative indices of the trained partners significantly exceeded those of the controls The former not only equalled but surpassed their formerly superior partners

Turning now to the control data, let us see to what degree the training influenced the elementary and the more complex functions respectively

Jumping Table 5 presents the data on jumping obtained before and after the beginning of the training. The figures show great progress in the two groups. The total percentage of the increment of the height of jumping in the trained group is 525 per cent, while in controls it amounts to 277 per cent. (The total height of jumping in the two groups before training was taken as 100 per cent) The average increment of height of jumping in trained was equal to 16.2 cm, while in controls it amounted to 12 cm, i e, the increment of the height was 1 3 times greater in trained than in controls. After training, the trained partners jumped 4 2 times better than they did before training The control partners (untrained) also showed striking progress, jumping 2 7 times better than before. However, the question whether or not the increment of the jumps in controls was the result of biological growth only remains to some extent unsolved We are inclined to believe that this increment was due not only to natural development of psychomotor functions but also to occasional unorganized training which took place during their games, or to some imitation of their partners The growth of the jumps of trained is, nevertheless, so great as compared with that of the untrained twins that one must assume that in the latter group the growth of jumping depends on training only relatively

What is the rôle of training in the development of this function in each trained partner taken separately, and what is the influence

TABLE 5
JUMPING

Before training				D, the mean for all	After training			
Pairs	Experiments	Control	D₁		Pairs	Experiments	Control	D₁
M	0 cm.	5 cm	—5 cm		M	20 cm	15 cm.	+ 5
L	0 cm	0 cm.	0 cm.*		L	20 cm.	10 cm.	+10
G	10 cm	12 cm	—2 cm		G	35 cm	30 cm	+ 5
P	10 cm	10 cm	0 cm		P	30 cm	20 cm	+10
	The mean height of jump = 5 cm.	The mean height of jump = 6 7 cm		Mean D = —1 75		The mean height of jump = 21 2 cm The increments in experiments = 16 2 cm.	The mean height of jump = 18.7 cm	The increment in controls = 12.0 cm Mean D = +7 5 cm

*Neither twin could jump at all

of training upon the intrageminal resemblance of the two partners?

In the first two pairs of twins, the partners subjected to training did not know how to jump at all but after the training period they reached the height of 20 cms. In the third pair the height of jumps of the trained partner increased three and a half times, and for the fourth pair 3 times. It is to be emphasized that the relations are reversed after training, i.e., in case the difference between the twins before training was negative (with a minus for the partner to be trained), it became positive after training (a plus for the trained) The average intrageminal difference before training was —1.75 cms, while after the training it amounted to +7.5 cms. Hence the actual difference as compared with the original one is equal to 9 25 cms.

Training thus decreased intrageminal resemblance by a factor of five.

Our conclusion from the above data is that the development of such an elementary motor function as jumping, which is characterized by a simple external and internal structure, proceeds very rapidly, relatively independently of training. Training markedly accelerates, nevertheless, the rate of this development.

Let us next consider a psychomotor exercise which is more complicated as to its external structure, and is yet elementary as to its internal psychological structure This function is that of hitting the mark by throwing the ball, which, as has been noted below, involves only the optical field.

As expected, the increase of precision in hitting the mark demands a more delicate movement, and proceeds with more intensity, than the development of jumping. The total percentage of the increase of precision of throws for the trained is 185 per cent, while in controls only a small increase of precision, equal to 119 per cent, may be observed. (The total number of points in the two groups before the beginning of training is taken as 100 per cent)

Table 6 shows that the increase in precision in the trained amounts to 1 5 points, while in controls it is only 0.4, i.e, the increase of precision in hitting the mark in trained is 3 7 times greater than in controls. This shows that training and education of a more delicate movement (in the present case, of the accuracy of hitting the mark) may be more effective than in cases of a more primitive function.

The rôle which training plays in the development of this function

TABLE 6

Hitting the Mark (Throwing) Before and After Training

Before training							After training									
Pairs	Experimental twins, number of points	'The mean for all	Control twins, number of points	Mean	D_1 for each pair	D for all the pairs	Pairs	Experimental twins, number of points	Mean for all	Increment in cm	Control twins, number of points	Mean for all	Increment in cm	D_1 for each pair	D for all pairs	Actual difference
M	18		2		—0 2		M	3.4			24			+1 0		
L	1 0	1 8	1 5	2 0	—0 5	—0.25	L	4 0	3 3	1 5	2 0	2 4	0 4	+2 0	+0.90	(—0 25 before training) + (+0 90 after training) = 1 15
G	3 3		3 5		—0 2		G	3 9			3.6			+0 3		
P	1.2		1 3		—0 1		P	2 2			1 9			+0 3		

is a disproportionate one. In the first and fourth cases the precision is increased twice, in the second case four times, and in the third case 1 2 times. The intrageminal relations are reversed in this case, i.e., if the difference before training was of negative sign, it becomes positive after training In this case also the trained twin surpasses the control The intrageminal similarity before training was equal to —0.25, and after training to +0 90 Hence the actual difference is equal to 1 15. That is, intrageminal resemblance is reduced by *a factor of five.*

These facts lead us to the following conclusions:

1 The spontaneous development of a more complex psychomotor function, which has not been subjected to training, proceeds more slowly than it does for the more elementary functions

2. The training or education of this habit as a consequence of exercises produces a considerable effect, which may be seen from the increase of the number of points of the trained over untrained twins.

Now let us pass to the analysis of our last exercise, to hitting the *mark by means of rolling the ball We have to deal in this case* with a motor structure which is superficially similar to the preceding one, but is complex in its psychological nature and takes place beyond the limits of the optical field Complicated motor coordinations of this kind may be genotypically and paratypically conditioned in differing degrees. Training may thus produce results which will differ from those obtained by training elementary coordinations

Table 7 contains the data concerning training The great influence of training upon the development of complex psychomotor co-*ordination should be noted first, it is indicated in that precision of* hitting the mark among the trained twins is more than four times as great as before training, while the precision of the controls is almost unchanged The improvement of the trained group is outstandingly high It may be inferred from the fact that during four and a half months the deviations in the trained twins decreased by 27 2 centimeters, while in controls it decreased by only 1.7 centimeters If we take the total deviation before training in the two partners for 100%, the percentage of deviation after training will be equal in the trained to 24 8%, and in controls to 92.6%, i e , a striking decrease is observed in the first case, while it is quite insignificant in the second.

TABLE 7

HITTING THE MARK BY ROLLING THE BALL

Before training							After training									
Pairs	Experimental twins	Mean deviation for all	Control twins	Mean deviation for all	D_1 for each pair	D for all the pairs	Pairs	Experimental twins	Deviation for all	Reduction of the deviation	Control	Mean for all	Reduction of the deviation	For each pair	For all the pairs	Actual difference
M	45 cm		14 cm		—31		M	10 cm			18			+ 8		
L	30 cm	36 2 cm.	20 cm.	23.7 cm	—10	—12.5	L	7 cm.			15			+ 8		
G	335 cm		21 cm		—14		G	9 cm	9 cm	27 2 cm.	20	22 cm	1.7	+11	+13	
P	35 cm		40 cm.		+ 5		P	10 cm			35			+25		
								Percentage of deviation 24 8 %			Percentage of deviation 92.6%					(—12 5 before training) + (13 after training) = 25 5 cm

In conformity with all these data the degree of intrageminal resemblance in each pair has changed. If before training the difference in hitting the mark could be expressed by —12.5 cms. in favor of the trained, after training it attained the value of +13 cms. The trained have equalled and outrun the controls. Hence the actual difference is 25.5 cms. The conclusions reached from analysis of these special data may be formulated as follows.

1. The psychomotor equipment of a preschool child exhibits an outstanding plasticity The standards of psychomotor functions set up for this age were surpassed. Some of the four-year-old children could jump as high as from 30 to 35 centimeters after four and a half months' training, while, according to the scale of Dr Oserezky, 10 centimeters should be taken for the normal height at this age Winding a thread from a bobbin on the finger while walking (a test intended for the age of six years) could be performed easily by four-year-old children after training in spite of the fact that this particular exercise was not included in the program of training

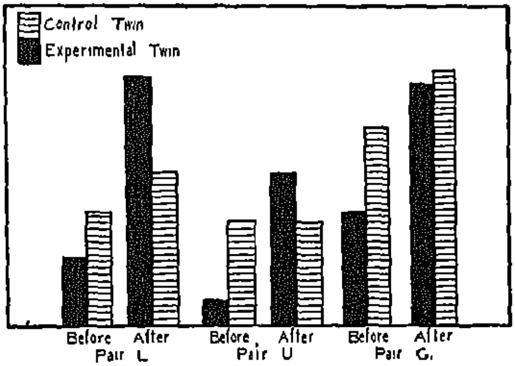

FIGURE 1

MOTOR ABILITY ACCORDING TO THE OSEREZKY SCALE BEFORE AND AFTER TRAINING IN EXPERIMENTAL AND CONTROL TWINS

2. Special external influences (in this case training) can sharply change the phenotypical expression of the psychomotor functions

3. The development of the more elementary psychomotor functions depends on training in lesser degree than do the more complex intellectualized psychomotor functions.

THE CHANGE OF BEHAVIOR IN THE COURSE OF TRAINING

Our attention is attracted by another fact which is of great importance for the education of a child. This concerns the general characteristics of the child before and after training We shall show below how great is the difference between the characteristics of the behavior of the child at the beginning and near the end of the training.

> At the beginning of the training the following picture could be observed the attention of the children was often turned away, they would become absorbed by the mere process of the exercise, without paying attention to the quality of performance and to the aim set before them; they would exhibit a lack of discipline, violate the rules, would not follow the requirements of instructions Their movements were sweeping, uncoordinated, and superfluous The auxiliary movements of the arms in jumping were disorderly or entirely lacking The children could not master a complex process, they were unable to cut with scissors while simultaneously turning around the picture Defense movements were absent or exaggerated. Speech (which may be classified as expressive movement) was abundant, noisy, and often accompanied with laughter

As may be seen from the above, some of the characteristics, such as ease of distracting their attention, instability, untimely functioning of automatic movements, unnecessary movements, and lack of precision in the movements, give the usual picture of deficiency of the neuromuscular apparatus in preschool children As regards their lack of discipline, mentioned above, poor pedagogical education may account for it [2]

Let us see now what occurs in their behavior towards the end of the training.

> We were able to notice from day to day a gradual decrease of superfluous and irrelevant movements The children not

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[2] It should be noted that the character of the involuntary automatized movements remained unchanged It is probable that the cortical mechanisms of the motor functions are more plastic and susceptible to external influences than are the sub-cortical mechanisms Among the latter are reactions to fear, to perplexity, to joy, movements of defense, mimicry, begging, crying, laughing, sitting, running, etc In such respects the training of arbitrary motor functions did not produce any perceptible effects.

merely jumped or threw to give escape to their muscular energy, but tried to accomplish some definite task, they took *sight at the mark for a long time; they controlled* the correct position of the arm and the trunk, begged to be paid attention *to* ("Look here, I'll hit the mark, *write it down in your* notebook"), they objected to the starting of a new performance unless the first one was satisfactorily accomplished, they asked for more complicated exercises, voluntarily increased the distance to the mark, or raised the string while jumping (while before they often asked to lower it, or set it themselves before jumping) Noise, talking, laughter, and running, which brought disorder and affected the discipline during the first experiments, gave place to silence At the beginning every movement was followed by a flow of speech, and provoked an outburst of exaltation or of distress Towards the end of training, however, untimely conversation had ceased The children first exchanged a few sentences referring to the exercises, and during their performances they were silent. In case one of the children spoke, be it in the lowest voice, the child who was performing commanded silence, and conversation ceased The movements became notably organized through the complication of exercises. The throwing of the ball through a 10-centimeter and through a 20-centimeter hole, for instance, were materially different performances When throwing the ball through a 10-centimeter hole, the child pulled himself together, sank down a little, sighted the mark, kept silent, and only after 10 or 12 seconds of such preparations, the trained child threw the ball When throwing the ball through a twenty-centimeter hole, the movements were less strenuous, the child sometimes talked, he felt easier, and the exercise looked rather like a game than a serious occupation

THE MANIFESTATION OF TRAINING IN THE GENERAL BEHAVIOR AND DEVELOPMENT OF THE CHILD

The degree to which the development of motor equipment influences behavior and general development was a problem which required very careful observation of the behavior of the twins during the time free of training An analysis of daily records showed that towards the end of the period of training the experimental twins exhibited better discipline during the lessons with the teacher (they set to work at once, were never late, and not so often broke the peace as the controls), and mastered more complicated situations of work and games sooner

The trained twins also performed better when they were off duty, participated more actively in the social life of the Kindergarten, and exhibited a greater independence and initiative in the organization of classwork. They consulted the teacher less often than the controls. During the modeling or drawing classes they set themselves a definite aim instead of merely working the clay and presented the material to the instructress, while the controls in most cases modeled simpler objects and seldom produced anything The trained handled the appliances more carefully and thriftily. According to the observations of the teacher of music, the trained more quickly understood instructions, and observed orders more strictly.

The testing of intelligence conducted at the beginning and toward the end of the training according to the method of Binet-Terman, gave the following average values:

	Before training	After training
In experimental twins	98	108
In controls	102	102

The intellectual level of the trained twins was raised as a result of the training, while in the controls it remained unchanged

The investigation of motor ability, determined by the Oserezky scale at the beginning and toward the end of the training, revealed a similar tendency, viz., the growth of motor skill in all trained children distinctly exceeded that of the controls, in spite of the fact that the exercises required by the Oserezky scale were not included in the training.[3] (See Figure 1).

It may be seen from the above that special training stimulates and organizes motor development, materially improves the whole behavior of the child, promotes his general development, and makes the latter "easier," to use the words of the pedagogues

Our data are in sharp contradiction with the conclusions drawn by Gesell. This writer maintains, first, that OET's are identical as regards motor equipment, and secondly, that external influences (training) do not produce any substantial effect upon the behavior of the child. The cause of this contradiction should obviously be sought in the developmental peculiarities of the motor functions of the child. Gesell had worked with one pair of infants (46 weeks old) only, the material we used for our studies was more extensive (4 pairs), and also of older age (from 4 to 4½ years)

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[3] The figure contains data on three pairs only, since the fourth pair, P, became sick toward the end of the training and could not be subjected to testing

In the case of infants we have to deal with a lesser differentiation and less development of cortical mechanisms than in the case of preschool children That is, in the case of infants elementary psychomotor functions dominate to a greater extent As we have seen, they depend on training in lesser degree than the complex psychomotor functions. External influences produce, therefore, less effect upon the motor functions of an infant than upon those of an older child It should be noted, besides, that in case the material is limited to one pair of twins only it is impossible to note the individual fluctuations of resemblance which undoubtedly occur. These fluctuations can be clearly seen on our material, which shows great intrageminal resemblance within some of the pairs, and less within others

The twin method thus makes it possible, first, to establish the degree of genotypical and paratypical conditioning of elementary and complex psychomotor functions; second, to bring to light the sense of a specific external influence upon the child; and, finally, it helps in establishing the relationships between different abilities and characteristics of behavior

The author expresses her deep gratitude to Professor Dr. S. G Levit for guidance and assistance throughout the course of this work.

SUMMARY

The purpose of this investigation was to study the following problems.

1. The degree to which complex psychomotor activity is conditioned genotypically and paratypically
2. The degree and the nature of the influence of training upon the development of psychomotor functions of different complexity.
3 The effect of training in psychomotor activity upon the general development of the preschool child

To answer the first question we investigated 4 pairs of OET's and 6 pairs of TET's aged 4 to 4½ years All of them lived in the Kindergarten of the Medico-Biological Institute. Observational data collected by the teachers, parents, and experimenters were systematically recorded.

The psychological examinations were conducted according to the Stanford-Binet, and the psychomotor functions were tested according to Dr. Oserezky's scale The observations on the behavior of OET's revealed, together with a very great resemblance, substantial differences, they were, however, smaller differences than those among the TET's The comparison of experimental data on motor functions and intellect evidences a considerable degree of genotypical conditioning of intellectual and elementary psychomotor functions. The motor functions which are characterized by more complex psychological structure are to a far lesser degree conditioned genotypically.

In order to throw light upon the second and third questions, four children, one (the inferior) of each of the OET pairs, were subjected to special psychomotor training over a period of four months and a half The remaining four were kept as controls.

The following exercises were used in the training · (1) Jumping, which is characterized by an elementary external and internal structure of activity, (2) hitting a mark by throwing a ball—an action which superficially appears to be more complex, but which is of elementary nature and is accomplished in a direct optical field; and, (3) hitting the mark by means of *rolling* the ball The last is distinguished from the second in that coordination is developed according to an internal sensory-motor scheme.

After four months and a half, the trained and untrained were again subjected to examination. It appeared that the inferior individuals had equalled and excelled the formerly superior ones. The three kinds of psychomotor activity were different with regard to the rate of their development The most elementary functions developed very rapidly, and were relatively independent of training; training did, however, accelerate this rate. More complex psychomotor functions appeared to depend much less on maturation, and were strikingly changed under the influence of training. After training intrageminal resemblance became several times less than it had been before training.

The observations show also that marked alterations took place in the whole behavior and in the general development of the trained twins They became more active, more independent, and more disciplined The intellectual level of the trained twins also rose in comparison with the controls. Some of the characters appeared to develop due to the direct influence of training, while others probably developed through the organization of the process of training.

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L'ÉDUCATION PSYCHOMOTRICE ET LE DÉVELOPPEMENT GÉNÉRAL DES ENFANTS PRÉSCOLAIRES QUELQUES EXPÉRIENCES AVEC DES JUMEAUX COMME CONTRÔLES

(Résumé)

On a fait cette investigation dans le but d'employer des paires de jumeaux pour déterminer (1) Le degré auquel l'activité complexe psychomotrice est conditionée génotypiquement et paratypiquement (2) Le degré et la nature de l'influence de l'entraînement sur le développement des fonctions psychomotrices d'une complexité différente (3) L'effet de l'entraînement de l'activité psychomotrice sur le développement genéral de l'enfant préscolaire

La comparaison des données expérimentales sur les fonctions motrices et l'intelligence montrent un assez haut degré de conditionnement génotypique des fonctions psychomotrices intellectuelles et élementaires Les fonctions motrices qui sont caractérisées d'une structure psychologique plus complexe sont beaucoup moins conditionnées génotypiquement. L'entraînement psychomoteur spécial dans une période de quatre mois et demi a montré que les individus inférieurs avaient égalé et dépassé ceux auparavant supérieurs Les trois sortes d'activité psychomotrice ont été différentes à l'égard de la vitesse de leur developpement. Les fonctions les plus elementaires se sont très vite développées et ont éte relativement indépendantes de l'entraînement, l'entraînement a, cependant, accéléré cette vitesse Les fonctions psychomotrices plus complexes ont dépendu, paraît-il, beaucoup moins de la maturation, et ont été changées d'une manière frappante sous l'influence de l'entraînement Après l'entraînement la ressemblance intragéminale est devenue moins de plusieurs fois qu'avant l'entraînement

MIRENVA

PSYCHOMOTORISCHE ERZIEHUNG UND DIE ALLGEMEINE ENTWICKLUNG DER VORSCHULPFLICHTIGEN KINDER EXPERIMENTE MIT ZWILLINGSKONTROLLEN

(Referat)

Der Zweck dieser Untersuchung war die Bestimmung der folgenden Punkte durch Verwendung von Zwillingspaaren: (1) des Grades, zu dem eine verwickelte psychomotorische Tatigkeit genotypisch und paratypisch bedingt wird; (2) des Grades und der Natur des Einflusses des Trainings auf die Entwicklung der psychomotorischen Funktionen verschiedener Verwicklung; (3) der Wirkung des Trainings der psychomotorischen Tatigkeit auf die allgemeine Entwicklung des vorschulpflichtigen Kindes

Der Vergleich der experimentellen Ergebnisse der Motorfunktionen und Intelligenz zeigt einen betrachtlichen Grad des genotypischen Bedingens der geistigen und elementaren psychomotorischen Funktionen Die motorischen Funktionen, welche durch verwickeltere psychologische Struktur charakterisiert werden, werden zu einem weit weniger Grade genotypisch bedingt Besonderes psychomotorisches Training uber einen Zeitraum von viereinhalb Monaten zeigte, dass die untergeordneten Individuen den fruher Überlegenden gleichten und sie ubertrafen Die drei Arten von psychomotorischer Tatigkeit waren verschieden in bezug auf die Schnelligkeit ihrer Entwicklung. Die Elementarfunktionen entwickelten sich sehr schnell und waren verhaltnismassig unabhangig vom Training Das Training aber beschleunigte diese Schnelligkeit Verwickeltere psychomotorische Funktionen schienen auf Motivierung viel weniger anzukommen und waren auffallend verandert unter dem Einfluss des Trainings Nach dem Training wurde die Zwillingsahnlichkeit mehrmals weniger als sie vor dem Training gewesen war

MIRENVA

SHORT ARTICLES AND NOTES

THE FACTOR OF DEGREE OF LEARNING IN REMINISCENCE A SECOND COMPARATIVE STUDY OF PRESCHOOL CHILDREN AND COLLEGE STUDENTS

GRACE O McGEOCH

PROBLEM

The phenomenon of reminiscence, which is the improvement in the recall of partially learned material after an interval during which there has been no formal relearning or review, has been studied by several investigators (4) but its conditioning factors have not yet been established. In recent experiments (5) designed to test the alleged inverse age-reminiscence relationship reported by Ballard (1) and Williams (6), no significant differences were found with respect to reminiscence between 100 preschool children and 100 college students with two sets of learning material The college students, however, attained about twice the degree of learning[1] of that of the children, i.e., they reported about twice as many items on the immediate recall[2] The experimental literature on reminiscence permits no definitive statement regarding the factor of degree of learning[3] In view of the fact, however, that under some conditions McGeoch (4) found a reliable tendency for the better learners to exhibit a greater average amount of reminiscence than the poorer learners, it is possible that the differences between the preschool children and the college students in the degree of learning might have been a factor in the absence of an age-reminiscence relationship.

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[1] Degree of learning in this paper refers to the percentage of the total material given in the immediate recall, not to how well that percentage was learned. Under the time-limit procedure employed it is probable that frequently the former varies inversely with the latter, i.e, the fewer items learned in the allotted time the better they would be learned because of the greater number of repetitions given each item. Under conditions of learning in which learning material of homogeneous difficulty is presented in such a fashion that each item is given the same number of repetitions during the allotted time, the two meanings of the term would approximate identity The meaning employed in this paper is determined by its prior use in previous experiments on reminiscence

[2] In this study it was concluded from an analysis of the immediate recall scores that the reminiscers did not vary significantly from the non-reminiscers in degree of learning The small number of reminiscers, however, and the narrow range of the immediate recall scores of the children (from 2 to 7 items) precluded decisive evidence of the influence of degree of learning upon reminiscence if this factor had been effective

[3] The conclusion was reported in an abstract (*Psychol. Abstracts*, 1933, 7, 4316) of a Yenching study (3) that a higher degree of partial learning resulted in a lower percentage of reminiscence A reprint of the study has been sent the writer by the senior author. It is unfortunate that the data on degree of learning in the Yenching study are presented only in terms of percentages of forgotten items and of reminiscent items and not in terms of the two more adequate measures of reminiscence, viz, percentage of subjects showing improvement in the total score and the mean amount shown

The present experiment was therefore designed to test the effect of degree of learning upon reminiscence by attempting to equate the degree of learning of the two age levels. Two more equivalent groups of preschool children were used, with whom the length of exposure time and the amount of material were varied. The influence of degree of learning upon reminiscence could thus be studied in two ways: (1) an age comparison with degree of learning equated; and (2) a comparison of groups of the same age who differed in degree of learning.

SUBJECTS

The data on the age and intelligence of the three preschool Groups,[4] I, II, and III, and of the college students, Group IV, are presented in Table 1 below. Group IV and 36 of the 50 children in Group I[5] were subjects in the previous experiment on age and reminiscence (5). With these two groups the number of items presented was 14 and the exposure time was 10". To Group II the same 14 items were presented, but the exposure time was 30", while to Group III only 10 of the 14 items were exposed for

TABLE 1

AGE AND INTELLIGENCE OF SUBJECTS

				Chronological Age			Intelligence Quotient		
Group	N	Items	Time	Range	Mean	σM	Range	Mean	σM
I	50	14	10"	60-71	66.52	.42	84-140	115.90	1.68
II	50	14	30"	60-71	66.60	.40	88-152	112.84	2.48
III	50	10	30"	61-72	67.30	.52	84-140	115.70	1.42
							Percentile rank		
IV	50	14	10"	204-246	227.90	1.44	3-89	35.50	3.23

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[4] The author here wishes to express her indebtedness to the teachers of the four kindergartens from which the children came: in Columbia, Mo., Miss Eleanor Taylor of the University of Missouri Elementary School; and in St. Louis, Mo., Mrs. C. Vaulx of the Flynn Park School, Miss Gosch of the Jackson Park School, and Miss Elise Beck and Mrs. Evelyn Campbell of the Wilson School.

[5] These 36 children were five years of age while the other 14 children were younger. The conditions of the previous experiment (5) were duplicated with the 14 additional five-year-old children in Group I of this experiment.

30". Each of the three preschool groups had an equal number of five-year-old boys and girls The IQ's of Group I are based on Stanford-Binet mental ages, while those of Groups II and III are based on the scores of the Pintner-Cunningham Primary Mental Test which was given by the writer under conditions favorable to group testing. The percentile ranks of the college students in Group IV are on the Thurstone Examination for High School Seniors and College Freshmen, 1931 and 1932 editions. It is evident from a study of Table 1 that the three preschool groups are practically equivalent in CA and IQ, since such small differences as do exist are not reliable Furthermore, the children came from homes of similar socio-economic level

PROCEDURE

The experimental conditions which had been used with Groups I and IV were duplicated with Groups II and III. The learning material[6] consisted of the following 14 toy animals cow, bear, giraffe, elephant, rabbit, dog, zebra, pig, lion, duck, tiger, cat, rooster, and horse. These were arranged in three rows with the first four animals in the upper row, the next four in the middle row and the last six in the lower row The animals were exposed on a kindergarten table, 36" by 18", with a sheet serving as both background and cover. The same material was used with Group II but the exposure time was increased from 10" to 30" With Group III the exposure time was again 30", but the number of animals was reduced to 10 by eliminating the four animals which had had the lowest learning indices, the bear, zebra, pig, and duck.[7]

All sittings occurred in a room in which only the subject and the experimenter, who was the writer, were present When the subject was seated across from the experimenter in front of the covered animals the instructions[8] were given The animals were then exposed Immediately after exposure the subject's oral recitation was recorded. One minute was allotted for this immediate recall After an interval of 24 hours, the subject returned to the experimental room, and, when seated again before the covered animals, was asked to name the animals he had seen the day before. The time given to this delayed recall was also one minute.

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[6] In the experiment on age and reminiscence (5) two sets of learning material were used, both of which had been selected on the basis of their approximate ease of acquisition for both preschool children and college students. Since the toy animal material yielded more reminiscence it was used in the present experiment The animals were obtained from Milton Bradley, Domestic Animals 8458, Wild Animals 8459 (1932 catalog numbers) The wild animals, which were not colored, were made similar in appearance to the domestic animals by water colors and shellac

[7] Thus with Group III the attempt to equate degree of learning unavoidably introduces a second variable, the factor of amount of material

[8] For *verbatim* instructions see footnote 4 in McGeoch's experiment (5)

RESULTS

Degree of Learning and Age. One object of this experiment was to equate the degree of learning of the preschool children and the college students so that a possible effect of this factor upon the age-reminiscence relationship could be determined. It is evident from a study of the data presented in Table 2 that the changed conditions in Groups II and III resulted in a significant increase over Group I in the mean immediate recall scores, thereby increasing the degree of learning, which is 41.71% for Group II and 53.40% for Group III compared to 29.28% for Group I. The attempt, however, to equate the degree of learning of the two age levels was unsuccessful since the college students, Group IV, had a degree of learning of 70.71%. This analysis, however, is based on the group average as the criterion of degree of learning. Although the differences in the mean immediate recall scores between Group IV and Groups I, II, and III are statistically reliable, nevertheless there is considerable overlapping, as the ranges given in Table 2 reveal. It would therefore be profitable to compare the degree of learning attained by the reminiscers among the college students with the degree of learning attained by the reminiscers among the children. These data are given in Table 3, a study of which reveals that only one reminiscing child out of the three preschool groups (the first subject in Group II) showed a degree of learning (57%) equal to that of any of the reminiscing students. Thus it cannot be determined whether the absence of age-reminiscence relationship previously reported is caused by differences between the age levels in degree of learning, since in this analysis both factors, age and degree of learning, vary.

TABLE 2

CORRECT ITEMS

			Degree of	Immediate recall			Delayed recall			% of
Group	Items	Time	Learning	Range	Mean	σM	Range	Mean	σM	Retention
I	14	10"	29.28%	1-9	4.10	.19	3-9	3.76	.24	91.71
II	14	30"	41.71%	3-11	5.84	.25	2-11	4.96	.27	84.93
III	10	30"	53.40%	2-9	5.34	.21	2-9	4.76	.18	89.14
IV	14	10"	70.71%	7-12	9.90	.19	5-14	9.35	.25	94.44

It is possible that some other combination or combinations of exposure time and number of items would yield a degree of learning in the preschool

TABLE 3

SUBJECTS WHO SHOWED REMINISCENCES

Group		Subjects											
		1	2	3	4	5	6	7	8	9	10	11	12
I	Degree learning	36%	36%	29%	29%	29%	29%	29%	21%	14%			
	Amount of rem.	3	1	2	2	2	1	1	2	1			
	Immed recall	5	5	4	4	4	4	4	3	2			
II	Degree learning	57%	43%	36%	36%	36%	29%	29%	21%	21%	21%		
	Amount of rem	3	2	1	1	1	1	1	1	1	1		
	Immed recall	8	6	5	5	5	4	4	3	3	3		
III	Degree learning	40%	40%	40%	40%	40%	30%	20%					
	Amount of rem	3	2	1	1	1	1	1					
	Immed recall	4	4	4	4	4	3	2					
IV	Degree learning	86%	86%	71%	71%	71%	71%	64%	64%	64%	57%	57%	57%
	Amount of rem	2	1	2	1	1	1	2	1	1	3	2	1
	Immed recall	12	12	10	10	10	10	9	9	9	8	8	8

children approximating that of the college students From observation of the subjects, however, the experimenter believes that increasing the exposure time would be of doubtful value in increasing learning, since, even during the 30″ exposure, the attention of these young subjects showed a tendency to wander If the number of items given on the immediate recall were to remain constant, decreasing the total number of items would, obviously, automatically increase the degree of learning. A further reduction in the number of items to be learned might bring the children's degree of learning up to that of the college students Such changes in the learning material, however, decrease further the similarity in conditions for the two age levels and thereby invalidate direct age comparisons. Furthermore it is interesting to note that, with the exposure time constant, decreasing the number of items presented did not increase the number of items given on the immediate recall· Group II recalled an average of 5 84 items out of 14 while Group III recalled only an average of 5.34 items out of 10.

These results thus suggest that, under our experimental conditions, the level of attainment in learning of college students cannot be reached by preschool children even when the children are given handicaps, and they thus constitute further evidence of the positive correlation between chronological age and learning capacity.

Degree of Learning and Reminiscence. Although the degree of learning of the two age levels was not equated, as has been shown above, the effect of one factor, the degree of learning, upon reminiscence can be studied by an analysis of the reminiscence exhibited by the three preschool groups who varied in the percentage of items given on the immediate recall. There are, however, no significant differences between the three groups in reminiscence measured in terms of the percentage of subjects exhibiting it, since 18% (σP±5.4%)[6] of Group I, 20% (σP±5 7%) of Group II, and 14% (σP±4 9%) of Group III yielded reminiscence. Moreover, the fact becomes evident from a study of the data in Table 3 that there are no significant differences in the amount of reminiscence shown The means for the three groups are 1 67 items, 1 30 items, and 1 43 items, respectively

The above results are based on the group as the criterion of degree of learning Although the differences in the mean immediate recall scores between Group I and Groups II and III are statistically reliable, nevertheless there is considerable overlapping, as the ranges given in Table 2 reveal A more adequate analysis of the effect of degree of learning upon reminiscence should be based upon the actual number of items given on the immediate recall irrespective of the group in which the subject learned

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[6] The sigmas of percentages have been computed from the tables by Edgerton and Paterson (2)

Out of 150 subjects, three groups of 50 each, 26 yielded reminiscence. The immediate recall scores of these 26 reminiscers are given in Table 3. The range is from 2 to 8 items, while the range for the 124 non-reminiscers is from 1 to 11 items. Within this somewhat narrower range for the reminiscers the distribution approximates the normal, being 2, 5, 12, 5, 1, and 1 for 2, 3, 4, 5, 6, and 8 items respectively. This analysis thus substantiates the preceding one in finding no evidence that reminiscence is a function of the degree of learning.

Reminiscent Items. The term reminiscence as used in this paper means improvement in the total score. The total score, however, represents a *balance between three types of items, remembered items, forgotten items,* and reminiscent items, which are those items appearing in the delayed recall but not in the immediate recall. It is obvious that the phenomenon of reminiscence is contingent upon the presence of reminiscent items. Although it has been shown above that the degree of learning is not a factor in the improvement in the total score, it is possible that this factor might have an effect upon reminiscent items.[10] An analysis of the data on the three preschool groups was therefore made on the basis of the reminiscent items shown. The results were negative as the following figures reveal: for Groups I, II, and III, respectively, the percentages of subjects yielding reminiscent items were 48.0% (σP±7.1%) 58.0% (σP±7.0%) and 46.0% (σP±7.0%), and the mean number of reminiscent items shown were 1.62 items (σM±.17), 1.50 items (σM±.16), and 1.43 items (σM±.14).

As has been discussed previously however, there is considerable overlapping between the three groups in degree of learning. The best learners (scores from 7 to 11 items) and the poorest learners (scores from 1 to 3 items) were therefore selected from the 150 subjects. The 26 subjects in the High-Degree-of-Learning Group had a mean CA of 67.90 months (σM±.67) and a mean MA of 82.77 months (σM±2.12), while the 24 subjects in the Low-Degree-of-Learning Group had a mean CA of 66.08 months (σM±.58), and a mean MA of 72.83 months (σM±2.84).[11] The percentage of subjects showing reminiscent items was 38.46 (σP±9.5%) for the High-Degree-of-Learning Group and 37.50% (σP±9.7%) for the Low-Degree-of-Learning Group, while the mean number of reminiscent items shown was 1.60 and 1.33 items, respectively. There is no evidence from this analysis, which corroborates the preceding one, that degree of learning affects reminiscent items.

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[10] The possible differential effect of degree of learning upon the two other types of items, remembered and forgotten items, making up the total score is an interesting question. In this paper, however, we are primarily concerned with the conditions causing items to be available in the delayed recall which had *not* been available immediately after learning. Moreover, the necessary differences in the experimental conditions of the three preschool groups introduce unknown factors which would limit the significance of any analysis of the effect of degree of learning upon remembering and forgetting.

[11] There is thus a slight difference in the mean CA and a considerably greater difference in the mean MA in favor of the High-Degree-of-Learning Group. The effect upon the results of the greater intelligence of this group cannot be determined but should be borne in mind.

SUMMARY AND CONCLUSION

Differences in degree of learning of the same material by three equated groups of five-year-old children were obtained by varying the exposure time and the amount of material. In spite of the handicaps given, not one of the groups of children equalled the degree of learning attained by a group of college students. These results constitute further evidence that learning capacity increases with chronological age.

Analyses of the data on the children, on the basis of the three groups as well as on the basis of the degree of learning of each subject irrespective of the group in which he learned, revealed no reliable evidence that degree of learning is a factor in the phenomenon of reminiscence or in the appearance of reminiscent items.

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RECOGNITION AND RECALL IN A VOCABULARY TEST

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There is a feeling widespread among faculty members that objective tests—if they must be—should be of the recall variety rather than the recognition type Recall tests, they say, *really* measure what the student knows, whereas recognition tests are more measures of guessing ability. Although a great deal of writing has been done on recall and recognition as factors of memory (Anastasi, 1), few investigations have been reported on the relationship between the scores on recall and recognition items as found in a typical achievement test A summary of investigations comparing different types of tests was reported in 1932 by Kinney and Eurich (2). Recall tests were generally found to be the most valid, the most difficult, and the most time-consuming tests according to the investigations, although the differences between the various test forms were frequently small. Many questions may be raised concerning the investigations reported

In the investigation here reported, a recognition vocabulary test of one hundred items of the best-answer (multiple-choice) type was constructed. The first item was

Aberrations from the truth 1—examples 2—deviations 3—soliloquies 4—arguments 5—dissipations

The student was to select the word which means most nearly the same as the italicized word in the phrase

A second test was constructed of the recall type No effort was made to equate the two tests. The same words were not used The first of the sixty items of this recall test was:

The pain a—(lessened) after the injections ——————

The student was directed to write in the space provided the omitted word in the sentence The initial letter of the word was given and one or more synonyms Although previous investigations suggest that one hundred five-choice best-answered items are equivalent in time to about eighty recall items (Ruch, 3, pp. 306-313), it was judged on the basis of experience with test-wise groups of superior students that sixty recall items were equivalent in time to one hundred of the recognition items However, no serious effort was made to equate the tests even in time

These two tests—unstandardized, unanalyzed, and unequated—were given to 174 students competing for a scholarship at the University of Chicago. The tests were two sections of a six-hour examination, the recognition test was the first part of the morning section, and the recall test the first part of the afternoon section There were no time limits for these parts of the test.

The number of correct answers on the two vocabulary tests were correlated. The Pearson coefficient of correlation was 863. The plot was tested for linearity by the Blakeman test, and found to be linear (η_{yx} = .876).

The reliability of the tests was computed on a sample of one hundred papers As each of the tests occupied two pages, the reliability was computed by correlating the first page with the second, and also, in the recognition test, by correlating the scores on the odd groups of five items each with the even groups. In the recall test, odd and even items were correlated In all four cases, the reliability of the total test was estimated by the Spearman-Brown prophecy formula The reliability of the recall test was odd-even items, 923, and one page against the other, 882 The reliability of the recognition test was· odd-even groups of five, 967, first page against second, 974.

The mean score on the recall test was 18.28 (σ_{dist}, 11 30); recognition test, 44 02 (σ_{dist}, 24 03). The total possible scores were recall, 60; recognition, 100

The theoretical relationship between the two functions measured by these tests may be estimated by correcting the obtained correlation for the errors of measurement The coefficient corrected for attenuation is 913 when the odd-even item reliabilities are used and 931 when the first- vs second-page reliabilities are used

The errors introduced by using tests which are not equated reduces the size of the correlation One may safely assume, therefore, that the true relationship is even higher than .91 to .93 In other words, a recognition and a recall vocabulary test give scores which correlate so highly that for almost all purposes the test may be used which on the basis of other considerations is the most desirable. As far as the type of vocabulary material is concerned, the happy guessers on the recognition test are also the happy recallers on the completion type of test

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A STUDY OF THE EMOTION OF EXCITEMENT

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I THE PROBLEM

In classifications and descriptions of emotions there has been evinced considerable interest in excitement It has been termed a "pure emotion" since, usually, there is no definite goal object to which it belongs If one is angry, he can fight, if he is afraid, he can run, if he is in love, he can speak and act accordingly. But excitement exists because there is no definite solution to the existing situation.

Stratton (1) says, "Excitement is our response to a situation which we recognize as calling for somewhat more than an easy and routine handling" He points out that an excited person tends to be active. The reverse may be true, as we shall show later. The activity may be haphazard, if it exists at all, since the person feels that something should be done, but can not decide immediately just what course to follow

Both Wundt and Stratton have made excitement one of their dimensions in presenting their classifications of feelings and emotions in diagram form. Wundt's familiar division presents the three pairs of excitement—calm, tension—relaxation, and pleasantness—unpleasantness. Stratton presents two pairs differentiated—undifferentiated, and pleasant—unpleasant. He considers anger the most highly differentiated and excitement the least Elation and depression are comparatively little differentiated, although more so than excitement.

A fundamental difference between the two theories is that Wundt lists calm as opposite to excitement, while Stratton contrasts it with anger. The two classifications, however, are for different purposes, Wundt's being to describe conscious experience and Stratton's to classify in terms of specialization.

It occurred to the writer that a study of the feelings and emotions in athletes previous to actual competition would give some data to settle certain of the problems arising in the discussion of excitement Here we have it in a natural state Excitement is very difficult to study from a laboratory standpoint, since its stimulus is indefinite In this way it differs from anger or disgust, which can be produced in an artificial manner

II *METHOD*

Since direct experimentation was out of the question, we asked athletes to write up their feelings before competition Their answers were guided by ten general questions, which were meant to serve as starting points for free expression rather than to force them to answer highly specific questions. The men were instructed not to limit themselves to answering just those questions which appeared on the list, but to add or omit as they saw fit, and to include any comments on the general subject of emotional feelings before competition they could give The writer was helped to some extent in devising the questionnaire from his own experiences in college and independent athletic competition.

The subjects were 25 college men, all varsity athletes, from the writer's classes in beginning psychology They were given the questionnaire just after emotions had been discussed as a class topic, so that they could express themselves more comprehensively Excitement, however, was never mentioned in lecture They were from a wide variety of teams· football, basketball, track, crew, golf, hockey, wrestling, boxing, and swimming.

III. Results

Complete statistical presentation of the results is impossible and inadequate, since we preferred to ask the questions in broad, general form, and to allow the subjects to express themselves in their own words We shall list the numbers of subjects who gave similar answers, where possible, and shall also quote certain typical statements used by the athletes in describing their feelings.

1 *Describe any physiological symptoms you have*

Frequent urination	15
Hollow feeling in stomach	15
Rapid heart beat	12
Dry mouth	11
Sweating	3
Hands sweat	2
Defecation	2
Muscular fatigue	2
Yawning or sleepiness	2
Cold chill or sweat	2

Concerning the frequent urination, mentioned by most of the subjects, there were some interesting comments Two were "I usually urinate several times while dressing, but the uneasy feeling still remains" "I have a feeling that I must urinate, even though I have just done so." The hollow feeling in the stomach seemed to be rather vague and difficult to describe One amusing symptom was, "It seems as though I had eaten some pancakes made by a newlywed wife"

Several swimmers comment that they will scoop up a handful of water just before the race, to relieve their dry mouth.

The rapid heart was described by several men as coming in spells, rather than persisting steadily for several hours.

2 *How long before the contest does excitement start?*

Less than an hour before	4
1-2 hours	2
3-6 hours (same day as contest)	5
Starts night before	2
24 hours	1
More than one day before	4

We see that the majority begin to get nervous during the day of the contest, and in some cases the evening before Several comment that excitement is worse on a trip when the game is out of town than when at home In some cases the excitement started as soon as the train left Also, excitement may start earlier during the week of the conference championship than for the early season contests We may give one interesting observation in this respect Chancing to drop into the gymnasium the day before the indoor track championships, I met and talked for a few minutes with the track coach A sophomore half miler came out in uniform, although they were supposed to rest that day, and asked if he couldn't be allowed to run a bit to relieve his tension Here we see excitement forcing the individual into action I suggested to the coach that allowing him to run a slow half mile might do him more good in relieving tension and enabling him to sleep than he would lose in energy consumption.

3 *Does it ease down before you start, say while warming up, or does it increase as the zero hour approaches?*

Increases up to start	11
Constant to start	4
Lets down while warming up	8
Vanishes when starting to put on togs	1

4 *Does it persist into the contest?*

No	6
Vanishes at start	13
Short time	5

These two questions may be discussed together. Stratton contrasts excitement with the more specialized emotions of fear and anger by saying that "in excitement there may be no clear impulse to any definite form of action" Our findings suggest that excitement is caused by inability to engage in action As soon as one can do something, the tension dies out With some, the mild warming-up sufficed, with others the actual contest dispelled the excitement A boxer pointed out that the tension was heightened by the rest prescribed by the coach Several football men reported that their excitement persisted into the game until the first bodily contact had occurred All in all, we may summarize this point by saying *that tension is caused, or at least augmented*, by inability to act, that is, restraint.

5 *Does it interfere with sleep previously?*

No	10
Yes	10
Occasionally	5

Several remarked that sleep was troubled before a very important contest, and that out-of-town games, with sleeping in strange surroundings, were more upsetting. A few reports were as follows: "I have had times when I ran my race a hundred times during my sleep" "I have trouble sleeping unless I have exercised enough to be tired" "It takes much longer to get to sleep the night before a game." "I tend to wake up early the morning of a game"

6 *Is it less for an easy game, or about the same for all classes of competition?*

Less	9
Same	13

Several athletes said that they were just as nervous before an interfraternity game as before intercollegiate competition Two said their nervousness depended more upon how the coach had worked them up than upon the strength of the opponents One track man said he was far more nervous if he had a good chance to win than if he was sure he could do no better than one of the last places The main cause of nervousness with many men is uncertainty as to how well they might do, regardless of the team as a whole. Even if a track man wins, his time or distance may show his performance to be mediocre, a football man of the winning side may be supplanted by his substitute.

7. *Compare the actual contest with your feelings during a practice scrimmage or time trial.*

Less in practice	4
None in practice	13
Some, when performance determined making the team	8

A crew man commented that he was more nervous the first day he was placed in the varsity boat than in later races A football man says, "Practice scrimmages cause no nervousness unless you are on the first team and your position is endangered by a comer"

8 *If you have competed more than one year, or during a long season, are there modifications in intensity of feelings?*

Constant	4
Drops during year	3
Drops in later years	8
Increases	2
Varies up and down	3

A complicating factor in this question is the fact that any single season leads up through easy games to a contest with the traditional rival or a conference championship meet

Several of the athletes suggested that the decline in excitement may be due to age or maturity, as well as to experience Others think that knowledge of one's real ability becomes more accurate as the season progresses, so there is less uncertainty as to what one will do This agrees with the answers to question 6 While the answers differ widely, we can generalize that there is no rapid or vast drop in emotions This in turn would show that this emotion is not subject to voluntary control, since it is felt chiefly in the visceral organs, which are under the autonomic system

9. *How does excitement affect your performance—help, hinder, immaterial, etc ?*

No difference	5
Helps	8
Hinders	6
Varies	2

The particular sport engaged in makes quite a bit of difference in the answer to this question Where the type of athletics demands crude energy, endurance, or sudden speed, the men seemed to feel that they were aided. But those who engaged in highly skilled sports, like golf or high jumping, did better the calmer they were A crew man stated, "I become tense and my muscles become tense and knotted"

This question ties up somewhat with 4 as to whether excitement persisted into the contest. A sprinter gave this observation, "I am usually rather excited in the first race, and this seems to help me But when I come to the final, I am perfectly calm and usually do worse." A cross-country man says, "I am so calm that I do no better in a race than in practice, while most of my team-mates do better. I get from third to fifth in practice, but finish sixth or seventh in the races."

10 *Can you describe your emotion as any one of the following: fear, dread, joy, pleasure, anxiety?*

The actual reports reveal one thing which can not be shown in this summary The feelings seem to be rather consistently unpleasant, in a broad sense That is, the athletes are in a distressed state and would like to get going as quickly as possible The wait is what is distressing.

A number commented that after play started, their emotion changed to joy or pleasure. The physical activity alone would not seem to account for this, as the same feeling would otherwise appear in a practice session The pleasure comes from competing against a rival, either in the form of a single person or a team One football man said that the greatest thrill he had ever experienced in his life was when the team had already scored two touchdowns against a strong rival and was on the way to a third.

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VISUAL THRESHOLDS OF REAL MOVEMENT IN THE CAT[1]

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An analysis of the capacity of animals for visual movement discrimination is of importance in the investigation of the visual mechanism. Throughout the phylogenetic series, moving stimuli are found to possess a marked efficacy in evoking specific forms of behavior The study of these responses is of special interest to the psychologist because of the significance of the results of the study of visual movement in the general theory of perception. In addition, the understanding of the stimulus and response characteristics of movement perception in relation to the function of special areas of the cerebral cortex is of significance because, as a stimulus, it has been suggested that visual movement may be "transitional" between the more primitive responses determined by brightness differences and the complex functions of elaborated pattern vision.

The present paper reports the preliminary behavioral aspects of experiments designed to ascertain the nature and modification of responses to visual movement in the cat before and after complete and partial removal of the visual projection area of the cortex

Figure 1 presents a photograph of the apparatus which is being used in the present study. The picture is a double exposure and does not represent the illumination conditions under which the experiments were carried out. All experimental work was done in a dark-room. The two lever-type discrimination boxes[2] contain ground glass diffusing screens on which the shadows of moving figures may be projected The arrangement of a pulley system and pulley tighteners, by means of which either stimulus

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[1] Presented at the Spring Meeting of the New York branch of the American Psychological Association April 13, 1935

[2] The discrimination methods here employed are modifications of an apparatus described by one of the writers (2)

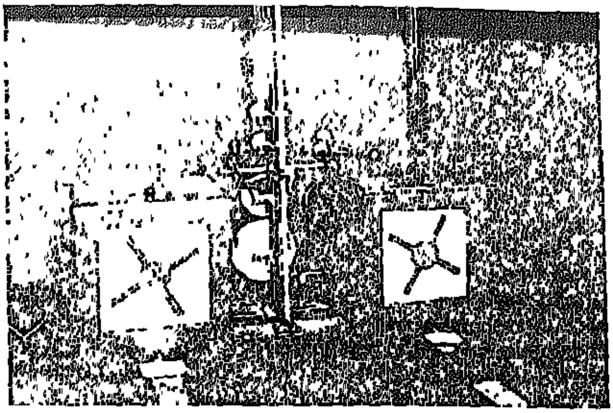

FIGURE 1

View from the restraining cage of the discrimination boxes and the stimuli used in threshold determination During trial periods the only light in the experimental room came from the backgrounds of the stimuli. It was therefore necessary to take a double exposure picture in order to present both apparatus and stimuli together

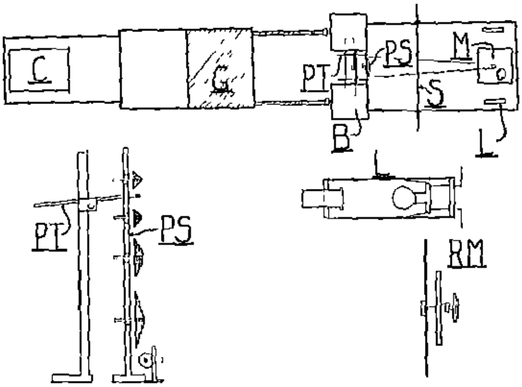

FIGURE 2

PLAN OF THE APPARATUS

This figure represents a top view of the complete apparatus, drawn to a 1-to-7 scale, with side views of the detailed construction of several important parts *B*, discrimination boxes, *C*, restraining cage, *G*, grills for the administration of electrical punishment, *L*, projection lanterns (also shown in detail below), *M*, electric phonograph motor, *PS*, reduction pulley system, *PT*, pulley tighteners, *S*, cardboard screen, *RM*, rotating mechanism for the stimuli may be made to move at any one of a series of speeds, is also shown. Figure 2 presents a schematic drawing of the arrangement of the complete apparatus as well as the detailed construction of several of its constituent parts The boxes (*B*) are constructed with plate-glass backs, at the center of which is fitted a shaft (see *R M*) that may be rotated by a small pulley attached to its end outside the box Inside, cardboard figures may be fitted to the shaft, the shadows of which are projected on the screens in the front doors Small, specially devised projection lanterns (*L*) are used as light sources. These are constructed from a length of 2-inch copper tubing, a 32-candle-power headlight bulb and an eyepiece of a common compound microscope A large cardboard screen (*S*) effectively eliminates all the light except that which illuminates the background of the stimuli The speed at which the moving figures rotate is controlled over a wide range by the reduction pulley system (P S) The whole moving mechanism is actuated by an electric phonograph motor (*M*). A calibrated dial on the motor, which was checked from time to time, makes possible the reproduction of different stimulus speeds The figure on the door of each box may be made to rotate or discontinue rotating by silently setting small pulley tighteners (*P T*)

Upon release from the restraining cage (*C*), the cat obtains food (small pieces of salmon) by proceeding down one of the runways and depressing a lever on the box containing the moving stimulus The grills (*G*) constitute the electrodes of a circuit through which electrical punishment of known characteristics may be administered The discrimination distance is 65 cm

Figure 1 also shows the stimuli used in threshold determination These were the shadows of crosses, 9 5 cm in radius with arms 1½ cm thick, situated on an illuminated ground

Six cats, five males and one female, one of which had been used previously in brightness-discrimination studies, served as subjects for the experiment reported here Two of these animals were found to be unsuitable for threshold work because of variability of behavior and were not extensively studied During the experimental periods, all the cats were maintained in a sufficiently hungry state to insure consistent activity over a 20-trial period although great care was exercised to keep the animals in good health and at approximately constant weight

The subjects were first trained to depress the lever and obtain food in a box of the sort described above but which did not involve moving stimuli Immediately after an animal had mastered the "lever habit," it was transferred to the moving stimulus situation, in which 20 trials per night, involving both double and single alternations of the position of the moving stimulus, were required of each animal Alternation of stimuli between the boxes was carried out in accordance with a chance procedure except when an animal happened to form persistent position habits. The criterion of learning was 90% correct choice of the moving cross in two successive trial periods, that is, in 40 trials.

After a stable response (determined by the above criterion) to an initial speed of 80 degrees of central angle per second had been established, the speed of the moving cross was reduced in small gradations until the animal was unable to discriminate between the moving and the non-moving stimulus figures. The movement threshold was arbitrarily taken as the speed at which the subject made only 75% correct choices in a 20-trial period and did not improve with subsequent reduction of speed.

Table 1 presents the learning records of the four animals who fulfilled the criterion. The results are given in sets of 40 trials, necessitating the averaging of scores and other slight masking of detailed data. Marked individual differences are evident since the subjects took respectively 200, 240, 320, and 480 trials before the accepted criterion of true discriminative response was reached.

TABLE 1

LEARNING RECORDS AT INITIAL SPEED OF 80 DEGREES OF CENTRAL ANGLE PER SECOND

Trials	% Correct choice of the moving stimulus Subj. 32	Subj. 24	Subj. 33	Subj. 34
1-40	70	50	45	60
41-80	90	50	50	65
81-120	80*	55*	70*	40*
121-160	75	60	55	70
161-200	95	80	70	65
201-240		90	85	40
241-280			70	40
281-320			90	55
321-360				70
361-400				80
401-440				80
441-480				90
Total trials to fulfill criterion	200	240	320	480

*Introduction of electrical punishment

In the four animals studied, the ease of initial learning was correlated with the magnitude of the movement threshold. Animals requiring fewer trials in the initial learning gave the lowest thresholds, while those requiring a greater number of trials had a correspondingly high threshold. Reference to Table 2 will show that the thresholds of real movement discrimination were respectively 2.6, 3.0, 5.5 and 14.6 degrees of central angle per

TABLE 2

THRESHOLD DETERMINATION

Speed (Degrees/second)	% Correct choice of the moving stimulus in the best 20-trial period Subj 32	Subj 24	Subj. 33	Subj 34
80.0	100	95	90	90
33.6	95	90	100	80
30.0	90	90	85	85
24.8	85	85	75	80
21.1	90	85		50
14.6	85	85	90	75*
11.2	75	90		55
6.5	90	90	80	40
5.5	75	90	75*	
4.3	75	80	55	
3.7	75	75	55	
3.4	65	85		
3.1	80	85		
3.0	70	85*		
2.9	85	55		
2.6	85*	60		
2.4	60			
2.2	60			

*Threshold speed

second. Table 2 presents the best 20-trial period at each reduction speed for each animal.

In order to study the stimulus situation further with the purpose of simplification, the animals were transferred, after thresholds were found, to stimuli of the same size and shape which, however, involved a reversal of the brightness values of figure and ground. Instead of black crosses on illuminated grounds, illuminated crosses now appeared on black grounds in the front doors of the boxes. No electrical punishment was used. To fulfill a criterion of 90% correct choice of the moving cross in 20 trials, the four subjects, previously trained on the other figure-ground pattern, now required respectively 40, 120, 20 and 40 trials. The second animal was used on a brightness experiment between threshold determination and transfer to the figure-ground change in stimuli. The results on this subject are therefore not comparable to those secured on the others.

Visual thresholds of real movement in the cat as determined by the present method are lower than for the rat. Hawley and Munn (1), using a discrimination technique and stimuli consisting of horizontally moving black and white gratings, found a variation of 3.3 to 10 cm per second in the movement threshold for albino rats. Their criterion was 80% choice of the moving stimulus in approximately 100 trials. In order to compare the results secured in this investigation with the rat and those obtained here with cats, the present data may be restated in terms of movement in cm. per second of a point on the circumference of the cross The threshold speeds for the four cats in terms of these units are respectively .4, 5, 9 and 2.4 cm. per second.

The fact that thresholds could be found with these animals indicates that movement was the differential stimulus in the situation The apparatus was almost noiseless in operation No differential sound stimulus could be obtained by the animal while in the restraining cage since constant, uniform procedure was used in preparing the apparatus for the next trial Check experiments have also been carried out in order to show that such factors were not involved in the discriminative responses of the animal. A large one-way screen placed in the experimental room served to eliminate all possible visual stimuli that the animal might receive from the experimenter

The main purpose of the present investigation, as stated above, has been the development of a systematic procedure for the quantitative study of visual movement in animals and to ascertain by ablation methods the degree of functional differentiation of the visual cortex of the cat in relation to visual movement perception Although all of the results are not yet available, it has been found that two animals, Subjects 32 and 33, relearned the original movement habit almost immediately after bilateral and at least relatively complete ablation of the so-called visual area of the cerebral cortex These animals also transferred directly in the figure-ground change of stimuli described above Marked modifications of thresholds of discriminative response to movement, however, have been found for these animals after the operation. A detailed account of these and additional results, together with data concerning the anatomical aspects of the brains of the sacrificed animals, will be reported in a later paper.

The results secured in the present investigation may be summarized as follows

1 A method is described by means of which a specific, discriminative response to visual movement may be established in cats and other small animals under simple but controlled conditions.

2 The responses found are not significantly disturbed when the brightness values of figure and ground of the stimulus patterns are reversed

3. Thresholds of visual movement discrimination in the cat are significantly lower than in the rat, a result which may be attributed to differences in experimental technique or, more probably, to the highly differentiated visual mechanism of the cat.

4 By the methods described, certain deficiencies in visual movement perception can be ascertained in the cat after bilateral lesions in the striate areas. A more extended description of this aspect of the present study will be presented at a future time

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QUANTITATIVE INDICES OF THE EFFECTS OF FASTING ON EATING-BEHAVIOR*[1]

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The obtaining of continuous graphical records of the amount of food eaten by an animal during a period of feeding is a fairly simple matter, and techniques for securing these records have been described by Skinner (7), Bousfield (1, 2), and Bousfield and Elliott (3). Inasmuch as an eating-curve represents the functioning of certain consummatory responses of a basic drive, the method should be capable of application to the problem of determining characteristics of motivated behavior. The most obvious procedure is to change the strength of the drive by imposing various periods of fasting, and then to mark any changes in the records of eating. Some of the results of just such an experiment have been described by Bousfield and Elliott (3). It was found that both the rate of eating and the amount of food eaten decrease with fasting, also that hungry animals eat more steadily and persistently. Records obtained in this way, however, have been subjected to further analysis, and it is the purpose of this paper to develop certain generalizations as a result of the study.

In the earlier papers cited above the writer has attempted to show that eating-curves may be adequately described by the modified exponential equation,

$$f = c\ (l - e^{-mt})$$

in which f = amount of food eaten, c = constant, e = base e of natural logarithms, m = constant, and t = time. An interpretation of the equation should simplify the discussion. In the first place, the curve described tends to approach a limit, and in so doing becomes progressively flattened, i.e., it approaches a horizontal asymptote This limit is represented by constant *c* in the equation, and it may be designated as the physiological limit of the animal's capacity for the food eaten under the specified conditions. It is evident that the eating-curve may rise steeply and thus rapidly reach the stage of flattening, or it may rise moderately and thus slowly reach the stage of flattening In other words, the approach to the horizontal asymptote may be subject to relative variations. Constant *m* of the equation represents the rate at which the asymptote or physiological limit is approached, and it may be called the coefficient of voracity.

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[1] The writer wishes to acknowledge an indebtedness to Professors William R. Ransom and T. E. Mergendahl of the Tufts College Mathematics Department for their assistance with the mathematical analysis on which the conclusions of this paper are based.

*Adapted from a paper read at the 42nd annual meeting of the American Psychological Association, Columbia University, 1934.

The questions that may be asked are. What happens to the physiological limit and coefficient of voracity, as calculated from the records, when the motivation is increased? Furthermore, are the results consistent with what is known of the physiology of hunger, and are they in accord with the psychological variables that are functionally related to inanition? An answer to the first of these questions is furnished from the results of an experiment in which control records obtained from rats during the regular daily period of feeding were compared with records after a fast of four days In every case there was a reduction in the physiological limit calculated for the delayed eating-curves. Data obtained from a group of seven subjects may be given to illustrate this point The average physiological limit for the controls was 26 6 grams, for the delayed records it was 16.3 grams The coefficients of voracity showed less consistency, but increased in all except two cases The average for the controls was 0 012, and for the delayed records, 0 015[2]

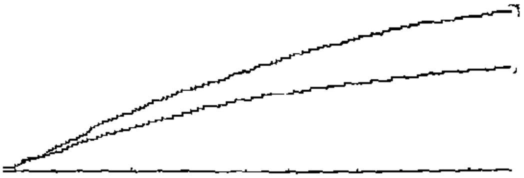

FIGURE 1

COMPARISON OF CONTROL AND DELAYED EATING-CURVES

This figure was made by superimposing the tracings of records obtained from one of the subjects The upper curve was secured during a regular daily period of feeding, and the lower curve after a fast of four days. Each step on the records represents the removal by the subject of a pellet of food (approximately 1/4 gram) from the recording apparatus The time-line is punctuated in units of thirty minutes

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[2] These constants are specific for the conditions of the investigation and the units used in the calculations The food-units employed in the derivation of the constants were grams of Purina Dog Chow, the food which was used throughout the experiment. The time-units were minutes

A typical sample of the eating-curves is shown in Figure 1. Even from inspection it is evident that the curve for the delayed record approaches a lower asymptote.

CONCLUSIONS AND DISCUSSION

The results definitely imply a reduction in an animal's physiological limit of capacity for food with fasting[3] In other words, with greater deprivation the amount of the satisfier that the animal can handle is less than normal. From the research of McCarrison (6, pp 69-85) we learn that the alimentary canal of the starved animal is in a state of genuine atrophy It would therefore be both impossible and undesirable for the fasting animal to eat a normal amount Lest this seem paradoxical, other evidence may be taken into account Starvation represents a true emergency condition, and the natural accompaniment of such a state is, as Cannon (4, pp 193-224) has shown, a mobilization of the sympathetic division of the autonomic system Consistent with this description is the marked hyperadrenalism which McCarrison (6, pp 156-173) found to be associated with inanition. Furthermore, a general increase in activity typically characterizes the state of hunger Givler (5) has pointed out that both tension and adrenin are actively present in motivation It is evident that the hunger drive involves no exception to this rule, and the motivated state is literally maintained at the expense of certain anabolic and vegetative processes

The average increase in the coefficients of voracity along with the reduced physiological limits of capacity means that the hungry animals tended in most cases to approach their limits relatively rapidly, that is, their eating-curves tended to flatten out relatively soon. This description of voracity would appear to give some measure of justification to common observation. But it should be noted that the hungry subjects ate at a markedly reduced rate.[4] There may appear to be some complexity in the statement that the approach to a low physiological limit can be relatively rapid, and yet the actual rate of eating is at the same time considerably less than that represented by a slower approach to a higher limit. To make a crude analogy, we may compare the coefficient of voracity with the rate at which a stream of water will fill a tank. One can readily imagine the conditions in which a small stream would more rapidly fill a small container than a larger stream would fill a larger one

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[3] It would be erroneous to assume that the stomach is in any way analogous to a passive bag Such phenomena as receptive relaxation should alter the physiological limit under a variety of conditions other than fasting

[4] A point worth emphasizing in this analysis is that while the action of the sympathetic division of the autonomic contributes to the facilitation of skeletal reflexes, the effect on the visceral reflexes concerned with the ingestion of food is one of inhibition. The decreased rate of eating with fasting may be due in part to lessened salivation. In situations where the secretion of saliva is not of essential importance for swallowing, the marked reduction in rate of eating would not be expected.

Some of the animals had a decreased coefficient of voracity *after fasting* In explaining the individual differences, it may be said that they should be expected The coefficient of voracity is one measure of the strength of the drive, and like other indices it is subject to wide changes both as a *function of time and as a function of individual* peculiarities That decreases in voracity should occur is not surprising when we consider such evidence as Cannon (4, pp 268-298) has reviewed of cases in which both human and animal subjects have shown relative indifference to food after fasting three or four days.

In summarizing the results of this analysis, it may be said that the changed character of certain consummatory responses *after the satisfier of* the drive has been removed for a considerable period of time indicates a reduced capacity to assimilate the satisfier. This change follows from the organic adjustment to the deprivation. A further effect of deprivation is that the limit of tolerance for the satisfier may be approached relatively rapidly *For an arbitrarily selected period of abstinence*, however, the opposite of this may take place and the limit of tolerance will be approached relatively slowly. This variability is justified by the assumption of individual variations in respect to a cyclic change

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THE INADEQUACY OF CURRENT INTELLIGENCE TESTS FOR TESTING KENTUCKY MOUNTAIN CHILDREN

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This report is taken from a survey which attempted to determine the intelligence status of rural school children in one mountain county in Southeastern Kentucky. The original survey[1] was undertaken in order to get some idea of the relationship between the intelligence status of rural school children in different parts of the county and their socio-economic status. This report is concerned with those facts from the original survey which throw some light upon the problem of the adequacy of current intelligence tests for testing mountain children

The tests used in this investigation were the Myers Mental Measure and the National Intelligence Test, Scale B These tests are too well known to demand much description The Myers test is a non-reading test, a single continuous scale, applicable to all ages beginning with kindergarten children It was particularly suited for this investigation since time did not permit individual testing or testing in age or grade groups. The National intelligence Test is a reading group test planned for use in grades 3 to 8 and with pupils entering high school Seven months after this testing was done a further study was conducted in which the Herring Revision and the Stanford Revision of the Binet-Simon tests were used.[2]

The Myers test was given to 363 children in 15 different rural schools (1 and 2 rooms) scattered rather widely over the county These children were scattered throughout the grades beginning with the second grade, and they ranged in age from 7 to 16 years. The schools were selected on the basis of a previous farm and home survey of the various school districts in such a way as to get children that were representative of the general rural population of the county The National test was given to 234 children above the second grade in 11 of these 15 schools The Herring and Stanford Revisions were given to 56 children from the above schools who were not in school at the time the group tests were given

Each child's score on each test was converted into IQ rating according to the norms published with the tests The Myers recommend the use of "Intelligence Ratio" (3) instead of "Intelligence Quotient" The norms for the National, on the other hand, are expressed in percentiles (4) IQ norms, however, are published for both tests In order to make a comparison between the two it was necessary to make use of the IQ *ratings* *The* distribution of IQ's for the 234 children taking both tests is shown in Table 1 The median IQ on the Myers test for this group is 67.7, quartile deviation 9.78 On the National the median is 71 5, quartile deviation 11.65 The median IQ of the 56 children on the Herring and Stanford Revisions is 72 85 The distribution of IQ's for this group is shown in Table 2

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[1] This survey was conducted by the writer under the auspices of the College of Agriculture, University of Kentucky, working in cooperation with the Bureau of Home Economics, Department of Agriculture, Washington, D. C.

[2] This supplementary investigation was made by the writer for the Bureau of Home Economics, Department of Agriculture, Washington, D C.

TABLE 1

DISTRIBUTION OF INTELLIGENCE QUOTIENTS FOR 234 KENTUCKY MOUNTAIN CHILDREN ON THE MYERS MENTAL MEASURE AND THE NATIONAL INTELLIGENCE TEST

IQ	Number of cases Myers test	National
140-144	1	
135-139	0	
130-134	2	
125-129	0	
120-124	1	
115-119	1	
110-114	3	
105-109	3	1
100-104	6	4
95- 99	8	4
90- 94	6	18
85- 89	12	17
80- 84	14	25
75- 79	16	26
70- 74	28	32
65- 69	35	14
60- 64	42	28
55- 59	19	27
50- 54	19	17
45- 49	15	10
40- 44	3	9
35- 39	0	2
	234	234
Median	67 7	71 5
Q	9 78	11 65

The IQ's of the 363 children taking the Myers test were tabulated according to chronological age The Median IQ of the children at each chronological age is shown in Table 3. Beginning with age 7, the median IQ for each age group decreases gradually and continuously from 83 5 at age 7 to 60 6 at age 15

These results are quite in agreement with the findings of Hirsch (2) In

TABLE 2

DISTRIBUTION OF INTELLIGENCE QUOTIENTS FOR 56 KENTUCKY MOUNTAIN CHILDREN ON THE HERRING AND STANFORD REVISIONS OF THE BINET-SIMON TEST

IQ	Number of cases
100-104	0
95- 99	1
90- 94	4
85- 89	4
80- 84	7
75- 79	9
60- 64	6
70- 74	7
65- 69	6
55- 59	4
50- 54	7
45- 49	1
	56

Median = 72.85

TABLE 3

THE MEDIAN INTELLIGENCE QUOTIENT ON THE MYERS TEST ACCORDING TO CHRONOLOGICAL AGE

Chronological age	Median Intelligence Quotient	Number of cases
7	83.5	25
8	75.5	29
9	74.25	47
10	69.05	51
11	66.5	49
12	64.25	52
13	63.25	43
14	63.3	28
15	60.6	15
16 (includes all ages over 16)	65.0	24

a more extensive survey of three mountain counties, one of which was the county of this investigation, Hirsch found a median IQ of 72.5 on the Dearborn and Pintner-Cunningham tests for 904 children. In a group of 1050 mountain children part of whom were from rural schools and part from community and settlement schools, he found a decrease in median IQ of 12 points from the 7-year-old group to the 14-year-old group.

Before attempting to interpret the results of this study, it is necessary to indicate briefly how the norms with which the children in this investigation are compared were obtained. The norms published for the Myers test were obtained from 1859 children from 6 to 17 years of age (3). As far as the writer is able to judge from the Myers' report these children lived in Cleveland, Altoona, Painesville, East Cleveland, and Cleveland Heights, Ohio The norms for the National Intelligence Test were obtained from 32,372 children from different communities as follows: 13,126 from cities and towns in Michigan; 1,060 from two cities in Kansas; 1,215 from one city in California, 1,470 from Washington, D. C; 7,552 from Youngstown, Ohio, 258 from Flemington, N J, 6,541 from Kansas City, Missouri; and 968 from Pittsburgh, Pa. (4).

If one compares the results of this study with the IQ norms published with these tests where IQ 100 is considered indicative of average intelligence, it would appear that the vast majority of the mountain children are below average intelligence Only about 5 per cent of these children have IQ's above 100 on the Myers test. If the comparison is made with the IQ ratings for the general population given by Terman where IQ 70 or below is considered indicative of mental deficiency or feeblemindedness, it would appear that about half of these children are feebleminded or grossly deficient mentally since the median IQ on the Myers test is 67 7 and on the National 71 5. Even if one follows Healy and Bronner (1, p. 155) in their suggestion that IQ 90 is near the average of the general population, an unusually large percentage of these children are of low intelligence. Only 13 per cent have IQ's above 90. Is one to conclude, then, that 20 to 50 per cent of the mountain children are feebleminded? Not until it can be shown that these children live in an environment that is as favorable for the acquisition of the knowledge demanded in these tests as that of the children on whom the tests were standardized, because it is generally agreed that differences on these tests are indicative of true differences in intelligence only when the environmental opportunities of the children taking the tests are approximately equal. What is needed here, therefore, is information regarding the environmental opportunities of mountain children in comparison with the children on whom the tests were standardized It has been pointed out above that the children on whom the Myers and National tests were standardized were from urban or near-urban communities.

Fortunately some information regarding the material environment of the mountain children is available from surveys of living conditions of farm families made by the Bureau of Home Economics, U. S. Department of Agriculture The following data are taken from a paper furnished the writer by Dr. Faith M. Williams, Senior Economist, Bureau of Home Economics, U S. Department of Agriculture The average money expenditure of 227 families in the mountain county where this testing was done was $450 in 1929 The average money expenditure of 2886 farm families in 11 states was $913, while the average money expenditure of a somewhat superior group of 40 farm families in Maryland, Vermont, and Illinois was $1684. The total value of living in these three groups is further indicated by adding the average value of goods and services furnished by the farm to the average cash expenditures. Measured in this way, the total value of living of these three groups amounts to $996 for the first, $1598 for the second, and $2560 for the third.

Still another comparison of living conditions in these three groups is found in the money value of the homes. The average value of the houses studied in the mountain county mentioned above was $340, while that of the homes occupied by 2886 families in 11 states was almost $2000, and the 40 account-keeping families cooperating with the Bureau of Home Economics occupied homes valued at almost $5000.

Information regarding the education of the families in the mountain county of this study was obtained in the socio-economic survey mentioned above. The average number of years of formal education of the 227 farm operators included in the survey was 6.6, of the home makers 6.0. The average number of weeks in the school year for the operators was reported as 18 and for the home makers as 15.9. The average expenditures for formal education for the group for the year 1929-30 were $11.67, and for reading matter $.87.

While data are not available for a comparison of these rural groups with city families, it is probably safe to assert that the limitations of the mountaineer's environment are even greater in comparison with city conditions than with the farm families mentioned above.

These comparisons and facts seem to point to definite limitations in the material environment of the mountaineer. No one will deny that this environment lacks many of the material things considered essential in better rural and urban communities. It lacks opportunities for social intercourse, and for education of the sort considered essential by outsiders. Different knowledge and skills are needed for successful adjustment to an environment where the spinning wheel is still used, where some of the inhabitants are still weaving fine woolen blankets and coverlets and making their own furniture; where churning, canning, butchering, etc., are routines in every home; where axes, plows, mules etc., are many times as important as books, papers, and pencils.

All of these facts indicate that the mountaineers live in an environment that *differs* from an urban environment or even from other rural environments. In view of these facts, one can hardly conclude that these mountain children are mentally deficient because they make low scores on intelligence tests which were constructed for and standardized on children living in another kind of environment. It is impossible to say from this study what their true intelligence is. It may be below that of children in other parts of the country on the average, but in view of the environmental differences indicated above the difference between IQ 68 or 71 for these children and IQ 100 for city children can hardly be said to be due in any large degree to differences in native capacity

The effects of the mountain environment on the IQ's of these children is also indicated by the facts in Table 3. In this table it is seen that the median IQ decreases with chronological age from 83 5 at age 7 to 60 6 at age 15 This is a decrease in measured intelligence on the Myers test of 22 9 IQ points As indicated above, Hirsch found a decrease of 12 points in median IQ from 7 to 14 years in a group of 1050 mountain children Part of this group, however, was from settlement and community schools where the opportunities for development are unquestionably better than in the rural schools This decrease in IQ with chronological age is what would be expected if the mountain environment differs from that of the children on whom the tests were standardized. The longer the children live in this environment the more its disadvantages will influence their scores on the tests

It appears to the author that tests constructed and standardized in one locality for and on particular groups of individuals should not be used in some other locality or on some other group with a view of making comparisons between individuals living in the two localities, unless it can be shown by experimental investigation that the one does not differ essentially in its opportunities from the other If the children in a mountain environment are given a test which measures the knowledge and skills in kind and amount of urban children, it seems obvious that the mountain children would be at a decided disadvantage unless they had had approximately the same opportunities to acquire this knowledge and skill as the urban children. The same could be said for racial comparisons. Of course such comparisons can be made, and one can conclude that mountaineers do not know what other children know or cannot do what other children can do, but it is just about as likely that the city children do not know some of the things that the mountain children know, things that may require as much ability to learn as the things which they do not know One could expect one or another result depending upon what kind of test item one included in his test.

SUMMARY AND CONCLUSIONS

The Myers Mental Measure was given to 363 rural school children in one mountain county in Southeastern Kentucky The National Intelligence Test, Scale B, was given to 234 children of this group. The Stanford and Herring Revisions of the Binet-Simon test were given to a group of 56 children who were not in school when the above tests were given.

The median Intelligence Quotient on the Myers test was 67.7, on the National 71.5, and on the Stanford and Herring Revisions 72.85 The median Intelligence Quotient on the Myers test for each chronological age group decreased gradually and continuously from 83 5 at age 7 to 60.6 at age 15

A survey of socio-economic status of farm families made by the Bureau of Home Economics, U S. Department of Agriculture, indicated definite limitations in the social and material environment of the farm families in this mountain county in comparison with farm families in other parts of the country.

It is concluded that these limitations are probably greater in comparison with urban or near-urban families The effect of these environmental differences on the measured intelligence of these mountain children is indicated in the decrease in median IQ with chronological age

It is further concluded that the differences in the social and material environment of Kentucky mountain children and children in urban communities are such that intelligence tests standardized on urban children are not adequate for measuring the kind or amount of intelligence of Kentucky mountain children.

In view of these differences the performances of Kentucky mountain children and urban children on these and similarly constructed tests are not comparable. Conclusions regarding the actual intelligence status of rural school children in the mountains of Southeastern Kentucky, as compared with that of children outside the mountains, awaits more adequate measuring methods.

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BOOKS

A. GESELL AND H. T. THOMPSON, assisted by C. S. AMATRUDA. *Infant behavior: Its genesis and growth.* New York: McGraw-Hill, 1934. Pp. viii+343. $3.00.

In this volume are presented the results of an intensive normative investigation of the growth of posture, locomotion, prehension, speech, and adaptive and social behavior during the first year. The method of approach, which is discussed briefly in the first two chapters of the book, is that for which the Yale Clinic of Child Development is so well known. General procedures, such as methods of obtaining the stenographic and motion picture records, are discussed in the first chapter. The second chapter describes the test materials and methods of administration. This discussion is not sufficiently detailed to enable others to administer the tests, but the authors mention a forthcoming monograph which will include the necessary data. These two chapters serve more to orient the reader not already acquainted with the methods of the Yale Clinic than to offer any original contribution.

The third chapter, however, comprises a report of the results of the investigation of behavioral growth. Over a hundred infants were observed in the study, but only seven of these were tested at all of the age-levels involved. The tests were administered at fortnightly intervals from the ages of four to eight weeks, and at monthly intervals thereafter until the age of fifty-six weeks. The lunar-month calendar was used. Detailed protocols, photographs, and interpretive comments trace the development of the infants' reactions to twenty-five standard situations. On the whole, each situation is rather specific, viz., supine situation, prone situation, stair-climbing situation, dangling ring situation, etc. The behavior manifested in each of these situations is divided, for purposes of analysis, into a large number of behavior items. Supine behavior is, for example, divided into sixty-nine separate items ranging from "head predominantly rotated" to "facial expression attentive." Similarly, prone behavior is analyzed in terms of forty-four items ranging from "head compensates" to "pushes upward and backward to sitting." For each situation there is a table indicating the percentage of infants manifesting a given behavior item at each of the ages. For example, in the paper and crayon situation which was first administered at thirty-six weeks, the item "marks on paper with crayon" has a frequency of appearance amounting to 5 per cent at thirty-six weeks, 15 per cent at forty weeks, 25 per cent at forty-four weeks, 38 per cent at forty-eight weeks, 46 per cent at fifty-two weeks, and 74 per cent at fifty-six weeks. The more than two hundred pages devoted to this chapter are concerned with such tables, photographs of the reactions of the children at different ages, and descriptive comments. Reliability is not discussed, but the authors promise that the forthcoming monograph entitled *Norms of infant development* will contain data on statistical and related biometric considerations In addition to any diagnostic value that the material in this chapter may possess, it does show very nicely the growth of behavior and thus should be of interest to genetic psychologists.

In a brief chapter concerning the ontogenetic patterning of behavior, the authors trace the development of various reaction patterns from their fetal origins to the end of the first year of post-natal life This is the best brief discussion of the ontogeny of posture, locomotion, prehension, manipulation, and general adaptive behavior that the reviewer has encountered in the literature It serves not only to relate post-natal with pre-natal development, but it presents a clear generalized recapitulation of much of the material gathered in the extensive tables

A chapter concerning mental growth and maturation evaluates the concepts of heredity and environment and maturation and learning in terms of the findings of this and other researches The evidences for maturation as against learning *per se* in the determination of the behavior patterns of infancy are related The conclusion is reached that maturation or growth, regarded as a function of the genes in relation to inner and outer environments, is the prime determinant of infant behavior patterns. Maturation is regarded "as part of a general process of developmental regulation as well as a morphogenetic process which works toward more or less specific end results. The total complex of growth, as it were, is always meeting 'problems' in the obstructions, stresses, and deficiencies of both internal and external environment. The maximum developmental success of the organism is rarely achieved but in all growing organisms there is apparently a tendency toward a maximum We may postulate this as a developmental principle and formulate it briefly as follows *Growth tends toward an optimum realization*"

In a final chapter the authors discuss the developmental diagnosis of infant behavior. Several principles which underlie such diagnosis are stated There is also a consideration of the limitations of developmental diagnosis and of its medical aspects.

The purpose in presenting this book is to "set forth normative data of development in such a way that the individual study and diagnosis of infant behavior status may be made more analytic and interpretive" Without the promised monograph on specific procedures and biometric conclusions and applications, however, this volume will probably be of restricted value to diagnosticians The authors assume, of course, that diagnosticians will use it in connection with *An atlas of infant behavior* and *Norms of infant development*. As it stands the book's chief value resides in its lucid and not too technical presentation of the methods and results of a significant approach to some problems of infant development. Genetic and child psychologists will find it a valuable supplement to their textbooks, since the student may trace for himself the developmental trends indicated in the tables and photographs. There is also much that will be of interest to the general reader

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